THE HIGHER USEFULNESS OF SCIENCE

WILLIAM EMERSON RITTER

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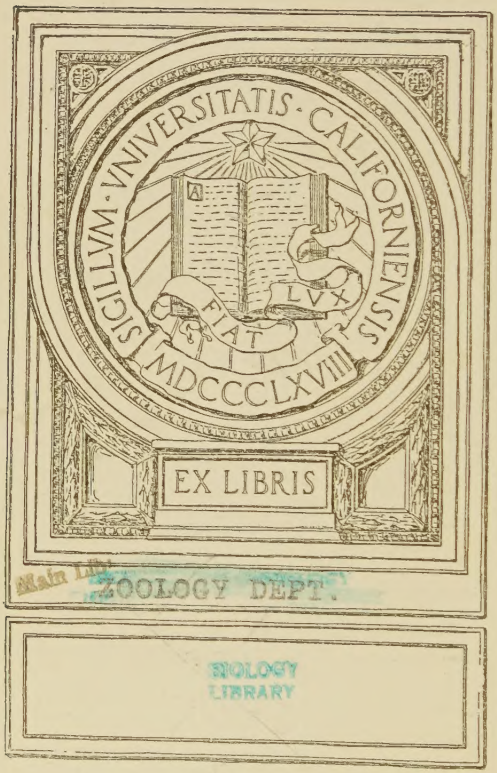

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Dr. Alice Robertson
with greetings from
old times,
. Wm. E. Ritter

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BOOKS BY
WILLIAM EMERSON RITTER

THE HIGHER USEFULNESS OF SCIENCE.

THE UNITY OF THE ORGANISM. *Illustrated.*

THE UNITY OF THE ORGANIC SPECIES, WITH SPECIAL REFERENCE TO THE HUMAN SPECIES.

RICHARD G. BADGER, PUBLISHER, BOSTON

THE HIGHER USEFULNESS OF SCIENCE

AND OTHER ESSAYS

BY

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Director of the Scripps Institution for Biological Research of the University of California, La Jolla, California

BOSTON

RICHARD G. BADGER

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TO

ELLEN BROWNING SCRIPPS

LOVER AND HELPER OF
GOOD THINGS

INTRODUCTION

READING these essays after the words and sentences which compose them have lain fallow in my mind for many months, I find myself beset with solicitude lest they shall not accomplish the purpose for which they were originally written, and for which they are now given book form. That purpose was to bring to the attention of the public—to educated, thoughtful people first, then afterwards to the intelligent rank and file—a certain way of looking upon the living world generally, and man particularly, which I believe to be vital to human welfare. The significance of the scientific point of view which underlies these essays has been gradually forcing itself upon my mind through many years, as, started from and impelled by purely scientific motives in the first instance, the standpoint itself has slowly taken shape. Now, the world-struggle at arms, in which our country has inevitably become fully involved, is upon us and convinces me more than ever of the mighty part "point of view," theory, philosophy—call it what you will—plays in the affairs of civilized mankind.

Who in the United States to-day, when the Nation is giving *for an ideal* its lives and its treasure with a lav-

ishness and an ungrudgingness that could not have been imagined a few months ago, has anything to say for the "practical" as a controlling motive in our lives? It actually seems that the broader the guiding theory —the idea and the ideal—the stronger its impulsion to activity! What broader and in many respects more imperfectly defined idea can you think of than "the world for democracy"? Yet somehow we are all certain it is a worthy, a noble idea—so worthy and so noble that we are glad to have it completely dominate our practical lives.

Theories are beyond question superlatively influential things among civilized men. And it matters little how broad and vague they are so long as we are convinced that they deeply concern our personal welfare and the welfare of our kind. In support of theories so appraised we are willing, finally, to give our lives and our consuming intellectual labor also, to gaining an understanding of them if only we are convinced of their human worth. Can we become as thoroughly convinced of the value of theories of life formulated by accurate, patient, dry science, as we are of the value of corresponding theories formulated by theology, or of the value of theories of national life formulated from political experience? If so, we will make sacrifices for those theories—sacrifices in the way of time and mental effort to understand them.

On considerations of this sort I base my hope that the ideas set forth in these essays and in other writings

of mine will win study. They will so win if the feeling is somehow aroused that they are vital to human weal. Otherwise they will not; for the essays are certainly not easily entertaining.

The teachings clustered together under the caption "organic evolution" spring to the center of one's thought at once when a scientific view of life is spoken of, for really there is no scientific theory of life which does not include an evolutionary conception of some sort. Further, evolution is probably rarely dissociated to-day in anybody's thinking from natural selection—from the doctrine of struggle for existence and survival of the fittest. But apparently few persons outside of Germany ever, until the great war came on, really thought out how the doctrine would work in actual human affairs if adopted as a guiding principle by a whole mighty people. I do not mean to imply by this that the biological theory of survival of the fittest is alone or even chiefly responsible for the philosophy which has brought this tremendous conflict upon the world. But there can not remain any longer a shadow of doubt that the doctrine has played a direct and very great part in shaping the German theory and practice of national life. This is especially evidenced by the glimpses Vernon Kellogg has given us of his experiences behind the German battle lines in Belgium and France, particularly of his conversations with a certain German officer, himself a professional biologist.

But probably a searching study of the whole problem would discover that the survival-of-the-fittest hypothesis itself has not been so large an element in determining Germany's course as has been a general view of life, individual and social, into which the narrower selection-theory could easily be made to fit. A theology the God of which is first and foremost a god of war may readily join forces, so far as its practical aims are concerned, with a general conception of the universe one of whose main tenets is that all progress in the living world is accomplished by omnipresent, ruthless conflict and destruction.

A point which I wish to emphasize is that while the general view of living nature to which I have been led recognizes the utter inadequacy of the natural selection hypothesis to account for the origin of the living world, and so the unjustifiability of applying it to the progress of civilization in such a manner as many persons, especially the Germans, have tried to apply it, the moral aspect of the matter was by no means the original, the impelling motive of my inquiries. Greatly important as I am now persuaded my results are in this way, they are yet only an incident, only a by-product, of the inquiries. All my efforts in the larger aspects of biology have been scientific in motive, and, I hope, in spirit and method. They have been induced by a deep-seated dissatisfaction with biological theories themselves, especially with theories of the cause of evolution.

It is desirable to call attention to the fact that in this respect the present case accords perfectly with doctrines of nature generally in their bearing on human welfare. No matter how vitally such doctrines may have turned out to affect human life, they had in the first instance no reference to such an effect. To illustrate: it probably did not occur to Copernicus till his work was done that his heliocentric hypothesis of planetary motion would be of much significance for men's religious and moral beliefs and conduct. And so was it with Galileo, with Vesalius, with Kepler and with Darwin. Nothing could have been remoter from Darwin's thoughts as he was working out the natural selection hypothesis than the fact that it would be made such use of as the Germans and others have put it to.

I dwell briefly upon this general principle with the hope that I may thereby win something of tolerance if, despite my anxious effort to be as simple and lucid as the topics treated will permit, I shall yet seem needlessly technical and shoppish and recondite.

Perhaps I had better state here in as bald a way as I can what the standpoint is in which I have so great faith as a medicament for the bloody and deadly philosophy of life which has come to dominate the world, and which Germany has outstripped all other countries in exploiting. The kernel of it is that the unifying, the coördinating forces of nature—all nature, but particularly animate nature—are far more fundamental and potent, and so philosophically sig-

nificant, than any doctrine of origination which has so far gained a dominating influence has taken into account. *Integration* is a term that has come much into use in my scientific thought and speech. It has become for me a complement, a *constitutive antithesis*, as I often express it, of *differentiation*. But differentiation has been the well-nigh sole conception of most evolutionary thinking up to now. Indeed, in many minds evolution appears to be nearly if not quite synonymous with differentiation. Hence the inadequacy of the doctrines. They wholly neglect or grossly slight one half of the process which nature actually employs in organic creation.

Assuming my main contention to be right, then the most superficial humanistic thinker will see that it is sure to be important for mankind. For is not the problem of the relation among men the very foundation of all social and political and moral theory and practice? What subject has occupied more of men's thought and feeling in these later decades especially, than that of combination, of coöperation, of unification in almost all the activities of civilized life? But if it turns out that some of the basal principles of such unification are embedded so deep in the nature of the living world and of man that they can be brought into light only through the most painstaking searches by a considerable number of persons who devote their whole lives to such pursuits, is it not probable that no matter how simply and lucidly these principles are stated, they

will still be somewhat involved, will not be altogether easy of comprehension? Indeed, is it not the way of much that is truly worth while to be a little hard in places, hard to understand and hard to endure?

I have done my best to make the arguments comprehensible to any educated person impelled by a *genuine desire to understand them.* These italicized words touch, as I have previously indicated, the cardinal question, the answer to which will measure the volume's fate. If a reader finds anything in the book—in its general title or the titles of any of the four essays, or in any of the subheadings, or any of the sentences or paragraphs taken by themselves, that makes him strongly suspect the discussions deal with matters of vital concern to him personally and to his fellow beings, he will follow the essays through and find few incomprehensible spots in them. I am quite sure there is nothing harder to understand in them than there is, for example, in the Book of Job, in some of Saint Paul's letters, or in parts of Mrs. Eddy's Key to the Scriptures and Guide to Health.

Each of the essays was written originally for a particular group of persons and a particular occasion, and each, consequently, bears the marks of its environment—in true bio-evolutional fashion. What the original and form-influencing environment of each was is indicated by a footnote appended to each essay itself.

The order in which the essays are placed in the volume is almost if not quite the reverse of that in which

the common point of view underlying them has developed in the author's mind. It is, too, the reverse order, probably, from that which would be congenial to most scientific men. If, consequently, the scientifically-minded reader, particularly if he be *naturalist*-minded, chooses to read the fourth essay first and the first fourth, he will, I assure him, come out at the same place, so far as the main thought is concerned, as though he were to read them in the order in which they stand.

The arrangement adopted is that which seemed most likely to gain the interest of the general reader. "Know Thyself" certainly skirts along the edge of a field which has interested many persons of diverse spiritual bent in many ages—even enters it here and there; so I have assumed that it would be more likely to make an initial appeal to non-scientific readers than would "The Place of Description, Definition and Classification in Philosophical Biology." What I have tried to do is to so bait my hooks that I may catch the largest number of readers possible *for all the essays.*

I am grateful to Professor J. McKeen Cattell for permission to republish "The Place of Description, Definition and Classification in Philosophical Biology," it having first appeared in *The Scientific Monthly.*

The Publications Committee of the University of Texas have kindly allowed me to reprint "Know Thyself," and I tender to these gentlemen my best thanks for this permission.

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THE HIGHER USEFULNESS OF SCIENCE

THE HIGHER USEFULNESS OF SCIENCE

KNOW THYSELF

*Interpreted by Socrates, Shakespeare, Harvey and Modern Men**

EVERY wise modern heeds the admonition, *Know Thou Thyself*, no less religiously than did that one of the Seven Sages who uttered it first. What do the words mean to-day? We no longer post them over the temple door of the Delphic oracle. But if we were to inscribe them on any of our temples, which should they be—those of Religion, Art, Education, or Science? Let my contribution to this festival week be a plea for renewed devotion to this injunction, and for the adoption of it in all our temples.

* Given originally as one of four addresses which were parts of a five-day Commemoration program of the Shakespeare Tercentenary and of Harvey's discovery of the circulation of the blood, at the University of Texas, April *22-26*, 1916, and first published in *A Memorial Volume to Shakespeare and Harvey*, by the University, as University of Texas Bulletin No. 1701, January 1, 1917.

Historically the mandate recalls unending discussions on abstract philosophy in a dusty, musty past, and causes something of a shudder; so the proposal to devote this hour to it may seem like proposing to make the hour dull and heavy. But we are living in a cruelly heavy time. No matter how determinedly we may resolve to forget for the moment the gigantic events in the midst of which we are, the deeper currents of our conscious lives can not escape them.

Calamity is the great tester of philosophy. A period like this reveals to men the sort of theories and ideals of life they have been nurturing as nothing else can.

The last few generations of Westerners have been boastfully confident that they have largely outgrown philosophy and have emerged finally into the clear light of practicality. But what disillusionment we are undergoing! Who does not see now as probably he never saw before, the necessity of probing to the roots everything pertaining to human relations? And does not about the first move in this direction discover that our supposed practical age has in reality been permeated with the most diverse and far-reaching though little criticized doctrines? A few students have been all along awake to the import of such doctrines as those of materialistic determinism in human history, of "economic society," and of Malthusianism; but not till lately have any considerable number of persons supposed that these doctrines were of much practical con-

sequence. How many, in our country at least, had even guessed before these last months, what a philosophy of Militarism and a theory of the State are capable of doing?

To know one's self implies a theory of self. The bloody disorder now filling the world is, I am persuaded, largely a consequence of inadequate and erroneous theories of self and of society, that have prevailed through the centuries, and though improved, still prevail. It has seemed to me that the occasion will justify us in thinking on this great matter even though our thoughts can be in baldest outline only.

My fundamental thesis is twofold: there are many more vital constituents in human nature than dominating theories of man have taken account of; and these constituents interact upon one another far more widely and fundamentally than theory has recognized.

To each of the great primal divisions of man's nature taken *separately*, to spiritual man and to physical man, great attention has been given. Particularly in previous centuries theology and philosophy wrought out doctrines of man's spiritual nature with unbounded zeal and industry and skill. And in modern times biology with its numerous subdivisions has builded in the realm of his physical nature with no less zeal and industry and skill. But never have the theories in the two realms been brought together into anything like a consistent harmonious whole. Indeed it has too often been a cardinal doctrine of each side that no such

getting together is possible; that its own triumph demands the utter subjugation of the other side. The misery that human-kind has brought upon itself through the false theory that success is attainable only by the complete overthrow of an adversary!

But it is undoubtedly true that in the two great realms of sociology and medicine, the enormous activity of recent decades is resulting, however vaguely the fact may be recognized, in breaking down the impermeable bulkhead that has so long separated theories of man's spiritual being from theories of his physical being.

That manufacture, trade, finance, and industrial and political organization, sanitation and criminology, are intrinsically physical no one can refute; yet the occasional excursions I have made into these fields convince me of a growing recognition among leaders, that no matter how severely material any particular problem may be, rational, moral, esthetic, and religious elements are always present and demand consideration. I am quite sure all economic theory to-day is seeing the inevitability and power of ethical factors far more than formerly.

In medicine, too, there is growing recognition that attention to physical matters alone can not reach the highest success in the actual task of restoring sick men and women to health, and keeping them healthy. No successful physician, I believe, wholly ignores the psychical element in his patient, however scantily his

formal training may have fitted him for this side of his work. The not distant future is, I think, bound to see the now rudimentary psycho-therapy work great changes in medical theory and practice.

The "get together" slogan of modern business is needed in modern philosophy. As a man of science I am filled with consternation as I come really to think about the part science has been made to play in the present world holocaust. Superposed upon the physical tragedy of the *Lusitania* I see another tragedy no less shocking—a tragedy of the human soul.

The civilization of the modern West is the climax of all the civilizations of the world, and its most distinctive attribute is physical science. So men of science have affirmed and hardly any one has questioned the affirmation. In no way, all agree, is the greatness of science more manifest than in its application to satisfying the practical needs and desires of man. And few achievements of applied science have been more applauded than the trans-oceanic liner.

Now behold the marvel that has come to pass! Science produces and successfully operates these noble ships and at the self-same time and in much the same way, not only produces an instrument for instantly destroying them but actually does destroy them, heedless that hundreds of innocent human beings are involved in the ruin! Has the world ever seen or conceived anything more astounding at the hands of man? Is it really true that the motive power behind civiliza-

tion can do nothing greater than find some means of destroying anything it can create? Is growth in civilization purely quantitative—purely a matter of giving the head-hunter's business greater scope and precision and power? Is the making of hell more hellish the supreme achievement of science? I do not believe so despite the strong evidence pointing that way. But scientific men ought to recognize that the share of blame and shame which falls to science is not small.

It would be unjust and foolish to contend under prevailing conceptions of right and wrong that moral culpability rests upon the chemists, the physicists, the engineers and others who have participated in making the war machine the dreadful thing it is. But when men shall come to know themselves and other men and nature as these really are, moral law if not civil law will, I believe, interdict science from lending itself to the dire business in such unrestrained way as it has hitherto.

To see something of the character of that knowledge of man and nature which would tend to such an end is the task before us.

That wonderful period, the later 16th century and the earlier 17th, in which the two great Englishmen lived whose works are the occasion of this week's meetings, contributed more, I believe, to such knowledge than any other period of equal length in the history of the world. Run over the list of familiar names be-

longing here. Galileo, Kepler, Tycho Brahe, Torrecelli, Giordano Bruno, and René Descartes might have seen Shakespeare act, had it been customary then for companies to which he belonged to tour continental Europe; and Francis Bacon and William Harvey may have actually seen him at the English court. Going only a trifle outside of Shakespeare's lifetime, the very year that baby Will's little lungs filled with air for the first time, Andreas Vesalius died a hungry outcast because of his offense in proving that if man would really know himself, one source of his knowledge must be the dissection of the dead human body. And "these bones" of the great author of his own epitaph were scarcely settled to their long rest before the mothers of Isaac Newton, John Boyle, John Mayow, Marcello Malpighi, John Ray, and Antony van Leeuwenhoeck had given birth to the baby sons destined to develop into these notable men.

Entering now a little further into the historical side of our subject, I ask you to recall the conditions under which Socrates took the exhortation, Know Thyself, as the text of his life-long sermonizing to his fellow Athenians. For a century before Socrates, the atmosphere of the little community was charged with speculation about the mode of origin of the world. We recall how a single, simple primal world-stuff as the basis of everything was a self-evident proposition to the Ionian school, while a thorough-going multiplicity or pluralism seemed equally certain to another school, the

later elaborators of the doctrines of Being and Becoming, who contended for the reality of the things as they transform into one another. We know, too, the conclusive arguments by which it was proved that Water, Air, and Fire is, each in turn, the "real thing" in the cosmic matter theory. Further, we know as much, perhaps, as we need to know about the atomism of Leucippus, the mind-stuff-ism of Anaxagoras, the numberism of Pythagoras, and so on. Some historians of philosophy have aptly called the first stage of Greek philosophy a cosmological period.

Then arose, according to wont in such cases, the strong, eager, independent and courageous protestant against the vapid metaphysics of nature then prevalent. The new seeker after truth was Socrates. "For heaven's sake," we seem to hear this young "knocker" exclaim after he had drunk his fill at the approved fountains of wisdom, "since we must philosophize, let us see if we can't find a way of doing it that will lead to something tangible and permanent, and above all, to something of consequence to human beings." About the chief ground of Socrates' rebellion was that man seemed to him left out of the systems against which he fought, while the only subject, thought he, worthy of serious study by serious men, is man himself. "God has commanded me to examine men," and "In the city I can learn of men, but the fields and trees teach me nothing," he said.

Despite Socrates' failure to do all he started out to

do and believed he was doing, we must, I think, recognize that he did two things that will endure forever and be true for all realms of knowledge. He drove home the truth that since all knowledge is man's knowledge —is wrought out by man for man—the human element can never be eliminated from it no matter how purely objective it may seem to be; and that the process of knowledge-getting itself must be critically examined in order that knowledge may be trustworthy. What greater service has ever been rendered mankind, what service is more needed in this very day, than that of convicting us of that "shameful ignorance which consists in thinking we know when we do not know"?

But while acknowledging Socrates' great merit in recognizing the necessity of critically examining the process of knowledge-getting, we must not be blind to the disastrous incompleteness of the results he reached by his own efforts. The theory of knowledge which he evolved was a theory of only one-half of knowledge. Know thyself, meant to him know thyself subjectively only. It did not mean know thyself objectively. It meant know half of thyself, not thy whole self.

Recall the interpretation he put upon the Delphic oracle's pronouncement that he was the wisest of men. He was wise, he said, because he knew he knew nothing, whereas others reputed to be wise did not know their own ignorance. But what sort of ignorance was it in which he gloried? Why, ignorance of everything except himself and "himself" taken subjectively. Refut-

ing the charge that "Socrates is an evil-doer, who meddles with inquiries into things beneath the earth, and in heaven," he insisted that it was false and unjust for Aristophanes to represent him as suspending himself in a basket and pretending that he was walking on air when, the truth is, he had nothing to do with these matters as all knew who had conversed with him. No one, he said, ever heard him talk about anything earthy.

Now for the fatal practical weakness in the Socratic interpretation of man. Did its doctrine of self implicate nothing but a theory of concepts and cognition, while it would be of much interest to psychologists and logicians and epistemologists, it would not vitally concern the great rank and file of men. But owing to the fact, which Socrates recognized, that a theory of knowledge does finally and inevitably implicate a theory of morality, and to the further fact that a theory of morality finally and inevitably implicates morality itself, it has turned out that this philosophy has been and still is of the utmost importance to the whole world affected by it, that is, to what we call the Western World. The kernel of the matter is that Socrates' doctrine of self was a doctrine of *my*self and not of *your*self. It gives an assumed reality and fundamentality to *me* that it does not give to *you*. It does not recognize that other selves are as essential to my existence as is myself.

The ethical system launched by Socrates and con-

tinued down to this very day is a system of subjective egoism. It never has recognized and is not capable of recognizing the real nature of human interdependence. It never has felt nor can it feel the full measure of man's obligation to man. That virtue which in the Socratic system is the concomitant of knowledge is not full and practical virtue. It is a virtue diluted with mock humility and aloofness from human affairs.

One other consequence of the Socratic theory of life must be noticed, though it will have to be touched even more cursorily than those previously noticed. Socrates "had it in for" the poets quite as well as for the wise men, i. e., the philosophers of nature. Why was this? That he should have had a grudge against the comic poets is not surprising, for he had felt the sting of their ridicule. But why did he pronounce the great tragedians and the others of his time as without wisdom, and so, according to his theory, without virtue? Because they too were too much occupied with other things than concepts. Like the physicists, they treated the world outside of and beyond themselves with too much consideration. Even their gods were more external and objective than he could tolerate. The point of consequence in this for us is that a great poet, as Shakespeare for example, deals with externality no less than does the physical scientist. The poet is an interpreter of nature—of sensuous nature—no less than is the naturalist. To him other selves are as real

and significant and interesting as our own selves, just as they are with great naturalists.

Look now in summary at what man's effort to know himself had accomplished by the time Socrates was compelled to drink the deadly cup.

First, the urgency of the problem had been more definitely and keenly felt than ever before. In the second place, it had been formulated with a fullness and definiteness that had not hitherto been approached. Further, the twofoldness of man's nature, his spiritual group of attributes and his physical group had been so sharply differentiated from each other that they had seemed to belong to two distinct realms of existence. So different in kind were the two groups seen to be that it was conceived they must have originated in antipodal parts of the universe and that their being together must be more or less fortuitous and temporary. The ultimate essence of man could not contain so much that is incongruous, contradictory, and even actively hostile, reasoned the leaders of thought of this early period. And so the two great currents of interpretation of man were started that have flowed down through the centuries of western civilization, each sometimes quite oblivious of the other, while at other times mingling more or less, too often in bitter jealousy and strife as to their respective rights and powers and excellencies. But it must be remembered that the separation has not always existed, with the whole human species. That it has particularly characterized west-

ern and Christian civilization is a fact of great significance. Especially important is it to understand that in western *Asiatic* civilization, the civilization from which Christianity came, there has never been any such sharp differentiation of the currents as the western world is accustomed to. On this point the testimony of Abrahm Mitrie Rihbany, a Syrian by nativity and early education, is invaluable. Here we only call attention to the entire absence in the philosophy of his countrymen, of a dividing line between the sacred and the profane, the natural and the miraculous. And it is significant that among the Syrians the absence of such demarcation has been attended with that "undisguised realism," using Mr. Rihbany's phrase, touching human propagation, which reformers in our own society are bent upon accomplishing.

Our study of man's effort to know himself must now fling itself across two thousand years to the period of Shakespeare and Harvey. Particularly must we inquire what Harvey did to further the enterprise of gaining self-knowledge.

But we must not enter upon this new phase of our study without recalling another ancient doctrine which has been and seems destined always to be of the utmost importance in its influence as a mediator between the two antagonistic interpretations of man. I refer to the doctrine of human brotherhood which first came to clear and measurably adequate expression in the teachings of Jesus of Nazareth. Despite the libraries that

have been written on this subject and the mighty force it has been in the lives of millions of men and women, I am persuaded the full meaning of it has not yet been grasped. Not yet has Anthropology accepted the objective phenomena of man's nature to which the doctrine answers with sufficient insight and freedom from doubt; and not yet has Christian theology searched deeply and broadly enough into the psychology of the emotional nature of individual human beings appertaining to their relations with one another.

Our study will bring us to touch upon this transcendently important matter later. For the present, William Harvey and his work primarily, and William Shakespeare and his work secondarily, must occupy us.

Taking up Harvey and his work first, we may begin by calling attention to the fact that while all biologists recognize that Harvey was the very embodiment of modernity in science so far as concerns the spirit and method of his work on the circulation, few notice that he was also a positively religious man. The testimony to this effect is ample.

We now look in the briefest way possible to so much of Harvey's work as pertains vitally to this discourse. The discovery of the circulation of the blood was the first great demonstration by rigorous methods of observation, experimentation and reasoning, of the various anatomico-physiological *systems* that enter into the composition of each higher organism. Harvey did not discover the several *elements* of the circulatory

mechanism: heart, arteries, veins, valves and so on.* These were known long before his time. What he did was to prove how these are interrelated, how they operate together and depend upon one another, how, for example, the work of the heart is supplemented by the muscularity of the arterial walls, and how the valves of the veins aid the veins in returning the systemic blood to the heart. Hitherto anatomy and physiology had been largely sciences of the members of the body. With this discovery they were started on their way as sciences of the *systems* of our members.

Discovery after discovery closely dependent upon that made by Harvey soon followed, revealing still further the nature and interdependence of the body parts. Only one group of these need detain us now. The demonstration of that interrelationship between the blood and nervous systems which constitutes the vaso-motor system, and which opened the way for our present insight into the so-called organic sensations and our physico-psychic conception of the emotions, must be counted as one of the greatest of the progeny of Har-

* Modern historical inquiries into the discovery of the circulation make it certain, as Luigi Luciani points out (*Human Physiology*, trans. by F. A. Welby), that Harvey's predecessors, notably Cesalpinus and Sarpi, came much nearer a clear understanding of the operations of the heart and blood vessels than Harvey's writings take cognizance of. The history of the discovery is highly interesting both scientifically and from the standpoint of the psychology of discovery; but the question of due credit to the various investigators who contributed to the final result does not affect the argument of this essay.

vey's germinal discovery. That the James-Lange theory of emotion may be regarded as a lineal descendant of Harvey's discovery, indeed was adumbrated by Harvey himself, is seen in his refutation of the old notion that the heart is the seat of the emotions. "Every affection of the mind," he writes, "that is attended with pleasure and pain, with hope and fear, is simply the cause of an agitation which extends to the heart and there induces change from natural constitution, impairing nutrition, depressing the powers of life, and so engendering disease."

Compare this with the following by Professor C. Lange, like Harvey a physician. "It is the vasomotor system that we have to thank for the whole emotional aspect of our mental life, for our joys and sorrows, our hours of happiness and misery. If the objects that affect our senses had not the power to throw this system into action, we should travel through life indifferent and dispassionate."

The conception of emotion held by modern psychology undoubtedly differs in important respects from that suggested by Harvey. But it is clear that they have this in common: all our deepest sentiments and passions, good and bad, are inseparably connected with and dependent upon our general body constitution, especially upon our vasomotor mechanism. It seems to be literally and not figuratively true that when we love or hate, are joyous or sad, feel exalted or depressed, kindly or hatefully disposed toward all

about us, and are intense about it, our whole being, body no less than soul, is fundamentally implicated. Nor does Harvey fail to let us know how his objective discoveries fitted into his deeper conceptions of life and nature. Two aspects especially of his researches brought him face to face with these larger problems. One was his study of the motion of the heart; the other his reflections on the blood as the vital fluid of the body. The highwater mark of his ability as a philosophic biologist is reached, I think, in his handling of these two matters. His main treatise, entitled "An Anatomical Disquisition on the Motion of the Heart and Blood in Animals," is devoted solely to an accurate and full description of the structure and operation of the blood system. Questions of ultimate causes and reasons he hardly touches in this book and when he does, only to show the error of some prevalent teaching. "Whether or not," he says, "the heart, besides propelling the blood, giving it motion locally, and distributing it to the body, adds anything else to it,—heat, spirit, perfection,—must be inquired into by and by and decided upon other grounds." *Observable facts first,* was his watchword. Casual explanations and appraisements of value and importance must come afterwards.

Two things in his ability to combine observation and generalization are supremely important. First, he did not for an instant waver in accepting the validity and the worth of the sensuous elements in knowledge. Soc-

rates' grilling dialectic would never have wheedled Harvey into admitting that there was no virtue in the knowledge he had acquired of the structure and movements of the heart, or that this knowledge had nothing to do with the sort of self-knowledge that saves souls.

The other notable thing in Harvey's mode of interpretation of natural phenomena was his insistence on a certain inherency and virtue in each object *itself*. He gave no quarter to that kind of explanation which tries to refer everything wholly to something else, which is always assuming that the final and real essence of a sensible object is something behind the object and wholly and forever hidden from the senses. His position on this matter is well brought out in a treatise, written some years after the publication of the original disquisition, refuting objections that had been made to his teaching about the circulation. Speaking on the old theory of an imponderable, spirituous something in the blood, he says: "Physicians seem for the major part to conclude, with Hippocrates, that our body is composed . . . of three elements: containing parts, contained parts, and causes of action, spirits being understood by the latter term. But if spirits are to be taken as synonymous with causes of activity, whatever has power in the living body and a faculty of action must be included under the denomination. It would appear, therefore, that all spirits were neither aerial substances, nor powers, nor habits, nor that all were not incorporeal. . . . The spirits

which flow by the veins or the arteries are not distinct from the blood, any more than the flame of a lamp is distinct from the inflammable vapour that is on fire, but the blood and these spirits signify one and the same thing though different—like generous wine and its spirits."

This reasoning of Harvey's about the spirituous qualities of the blood is not materialistic, as some careless readers would take for granted. It is not because it no more questions the reality of spiritual qualities, that is, qualities of whatever sort have "power in the living body," than it questions the reality of physical qualities. *Blood*, notice, not living matter, is what Harvey is talking about. He is not postulating something or other *behind* blood that explains its life-giving attributes. Nor has the vast chemico-physical knowledge of the blood acquired since Harvey worked, altered one whit his interpretation of the nature of blood. And his mode of reasoning is just as applicable to the brain as to the blood. One of the worst misdemeanors the transcendental physiology of our day is guilty of, is the application of the term epiphenomenon to consciousness.

While Harvey's researches on the blood system were undoubtedly far and away his best, what he did on generation can not be neglected even in a brief review of his contribution to man's knowledge of himself. The most important aspect of his treatment of this subject is the extent to which he compared man with other

organisms. We have emphasized the fact that the discovery of the circulation was a preëminent forward step in men's perception of the order, the unification there is in his own *individual being.* The studies on generation coupled with those on the circulation (for whatever subject engaged him, Harvey never neglected to compare man with all the creatures, high or low, he could get hold of) undoubtedly contributed greatly to man's perception of himself as a member of the great system of the living world. The demonstration of the circulation was a revelation of a prime unity *within* the *individual* man. The studies on generation, while resulting in no single discovery of first rank, were definitely on the road to the demonstration of the individual's unity with organic nature as a whole. "By the same stages in the development of every animal," he said, "passing through the constitutions of all, I may say—ovum, worm, embryo—it acquires additional perfection in each." He certainly came very near the now familiar truth that the egg is the starting point in the life career of almost all animals.

Is it not obvious then, that by the end of the great era we are now commemorating, men were coming to see more through the work of Harvey than through that of any other one person, that the ancient motto, Know Thyself, could not be restricted to the temples of religion and philosophy but must be placed in those of science as well?

Now as to whether the work of Shakespeare likewise

contains evidence of a growing perception of the essential unity between the physical and the spiritual. The poet seems to be the preëminently skilled guesser of the human species. He is endowed above all others with the faculty of apprehending from afar the hidden truths of nature. Not in imagination only, but in the quality of sense perception is he superior to other men. He seems to know what is "in the air" of his time better than anybody else.

To Shakespeare man was the most absorbingly interesting of all animals. He regarded his fellows not as problems to be minutely investigated, but as creatures to be watched for the purpose of guessing what they would do under hypothetical conditions.

Just what sort of a mixture of the natural and supernatural the animal is which interested him so supremely, seems always to have puzzled Shakespeare. That he could make Macbeth, about as unmitigated a clod of animality as can be imagined, scare the spirits into telling him what he wanted to know by threatening them with an eternal curse, illustrates the puzzled state of his understanding. But on the whole it appears that not only did Shakespeare find the natural the distinctly larger ingredient in the mixture, but that as he grew in experience and insight, he saw more and more of the natural and saw its meaning more clearly.

From *Venus and Adonis*, one of his earliest productions, to *The Tempest*, one of his latest, I seem to find a distinct advance in this matter. Possibly my

interpretation of Prospero is forced into conformity with my preconceptions, but does not his setting free of Ariel and Caliban, half-natural beings upon whom he had relied for some of his wonder-working, and his abjuring of "this rough magic," and his breaking of "my staff" and burying it "certain fathoms in the earth," as he attains the highest level of forgiveness and well-wishing toward those who had wronged him, mean that only when he became a man and a man only, was he at his best? One of the most useful bits of Shakespearean philosophy I have come upon is contained in the advice of Prospero to the King of Naples who is perplexed because there "is more in this business than nature was ever conduct of."

> "Sir, my liege,
> Do not infest your mind with beating on
> The strangeness of this business; at picked leisure
> Which shall be shortly, single I'll resolve you,
> Which to you shall seem probable, of every
> These happened accidents; till then, be cheerful
> And think of each thing well."

Before you jump beyond the bounds of nature for the explanation of things that are hard and strange, think well and cheerfully on each item and decide which of the several possible explanations is the one most probable. What more wholesome counsel was ever given! I am sure Socrates never advised more

wisely.

So I think we must conclude that this supreme poet, too, helped to convince man that if he would really know himself, he must know himself as a physical as well as a spiritual being. The ancient injunction must be adopted in the temples of Poesy and all Art no less than in those of Philosophy and Religion and Science.

What, finally, is our era contributing to man's understanding of himself? What does—what must—the injunction mean in the light of modern knowledge? Under the necessity of being brief we will limit the inquiry here to the realm of objective science, and will notice six great achievements during the three hundred years since Shakespeare and Harvey, which seem to me of great importance in their bearing on the question. These are (1) the formulation of the law of gravitation; (2) the discovery of the law of conservation of energy; (3) the demonstration of the absolute dependence of living beings on a few well-known non-living chemical substances and physical conditions, and the discovery of many of the laws of this dependence; (4) the demonstration that both individual living beings and kinds or species of such beings, originate from other individuals and species, and so far as can be made out, that they originate in no other way; (5) the demonstration of the enormously wide, if not the universal prevalence in the living world of individual specificity, so deep-seated as to implicate

much of the individual's chemico-physical constitution; and finally, (6) the demonstration by anthropology in all the human species so far rigorously investigated, of the whole range of attributes, physical and spiritual, that are most characteristic of the species. These achievements of science I count not necessarily as the most important from all points of view, but only from their bearing on the problem of the fundamental unity or, as it seems to me better expressed, integratedness, of the individual man; and of the fundamental integratedness of the species man with nature generally.

(1) Let gravitation stand as the type of physical integration, and let us remember that we have absolutely no experimental ground on which to base a speculation as to how any one of the myriads of bodies in the universe would behave were it entirely alone. The very terms in which the law is stated imply at least two bodies without an intimation that either is more important, more ancient or more causal than the other. Each not only moves but exists in virtue of the existence of the other. And do not neglect to notice that a man is no less subject to the law than is any other body.

(2) The law of conservation practically implies transformation coextensively with conservation. It would be meaningless without transformation. Evolution, taken in the most general sense, is but another form of statement of the laws of transformation and conservation. Gravitation is a universal law of *sus-*

tentation for bodies; while transformation is a universal law of the *origin* of bodies.

(3) The dependence of living beings on chemical substances is only a special case of the general law of transformation and conservation; but the discovery of it merits inclusion in our list of science's prime achievements because of its great importance to the problem of man's dependence upon nature.

(4) Concerning the origin of individuals and species, the transformations involved are of two radically different sorts. First, there is the sort known as organic evolution, which does not consist in a literal transformation of parent into offspring, that is, in a changing over of parent into offspring without loss of weight as one physical or chemical body changes into another, but rather in a growth of the derived individual or species from a small portion of the parent. And second, this growth is accomplished by the transformation of foreign substances into the growing organism through the nutritive process.

(5) The far-reaching facts of what I have called individual specificity among organisms have only lately come clearly to light, and even yet their significance is but vaguely seen. In the middle and later years of last century, biologists talked much about Protoplasm, written with a capital P, the assumption being that there is one simple substance common to all life. But the capital P has gradually disappeared from scientific writing, for we are learning that each species and indi-

vidual has its own particular protoplasm. Similarly the notion was formerly prevalent that germ cells of animals are practically alike. But closer scrutiny has revealed the fallacy of this idea. We now know that the germs of different organisms are in their fundamentals as different from one another as are the full-grown organisms; and we view the egg from which an individual animal grows as that individual in the one-celled stage of its life. Do you not perceive something of the important difference of viewpoint here? If from the simplest and earliest stage of its existence, each individual is to some extent different from every other, it is so far self-responsible for its own future development and activity. Growing at the expense of the few inorganic substances which are the common bounty of all living beings, it and it alone must have the ability to transform the common substances into its own special substances. Each organism is indeed a chemico-physical machine, if one chooses so to call it, but it is a particular machine—in deepest meaning a *self*—for it has an essential part in its own making and in the preservation of its own identity. The supreme significance of modern biology to philosophy is the establishment of both the inviolability of the individual and the interdependencies within and among individuals as never before have these truths been established.

(6) Another set of facts which science has only recently brought home to us is the universality in the human species, however low in culture racially or

individually, of at least the rudiments of all those attributes which characterize the highest of the species. Although increase of information in one quarter has continually strengthened belief in the origin of man from some lower animal, accumulation of knowledge in another quarter has completely annihilated belief that there is on earth now or for millenniums has been a being even approximately transitional between man and beast. All the races whose culture we know anything positive about are indubitably men. The existence of highly elaborated language, and of at least the beginnings of social institutions and laws, poetry, delineative art, religion, and reasoning about nature, among all people to which science has had access, has put a quietus forever on the old notion that certain primitive races are "hardly human," are "little, if at all, above the beasts of the field," are "without souls."

A fact the significance of which seems not to have been dwelt upon by writers on morals is that anthropologists who study primitive races long and closely in their homes, always, so far as I have observed, come to have a much higher regard for these races than chance and superficial acquaintance suggest. And frequently this regard ripens into genuine esteem, even affection. Inquiry into this matter ought to yield interesting results. Is the affection which grows up between the investigator and the savage investigated merely that which subsists between the owner of a pet dog or cat or horse and his chattel, or is it more akin

to the affection of friend for friend? Which cares more genuinely for nature people, the missionary who lives among them to save them for a future world, or the scientist who lives with them in order that he may know them? Is the missionary ever really successful in his mission of soul-saving until he comes to have a genuine interest in his people as physical beings—a genuine solicitude for their physical as well as for their spiritual welfare?

I suspect that some of the strongest practical evidence in favor of the doctrine of the brotherhood of man may be found in the intelligent affection which grows up between highly cultured Caucasians who live long and intimately among primitive peoples for the purpose of knowing them and helping them.

One of the most significant things about the humanness of nature peoples is the seeming coincidence of the main categories of human faculty. There appears to be no observational evidence that some one or a few of these attributes are more primitive than all the others and gave birth to the others. There is, for example, no proof that rationality preceded and produced the esthetic, the social and the religious instincts; or per contra. It seems as though all these must have emerged together or nearly so, and that they must have always been closely interlocked and interdependent.

The evidence as to the exact manner of man's origin contains much that is conflicting and exceedingly puz-

zling. The situation is certainly one in which Prospero's advice to Alonzo should be heeded. It calls for careful, cheerful search for what is most probable rather than for dogged defence of some theory held as though it were absolute and sufficient truth.

Does this meager narrative of the achievements of science which bear on the problem of man's nature and his place in nature fail to convince you that science has something basal and indispensable to contribute to man's understanding of himself? Is there any question that the injunction of old should have a prominent place in the temples of science as well as in those of philosophy and religion and art?

What bearing has the argument presented on the transcendent question of how men and nations should treat one another—should behave toward one another? Among the teachings about the nature of morality that have been potent in the history of mankind, there is one which says that the world itself is a moral order —that all things work together for good whether you love the Lord or not. I hope the reader will see that the conceptions here sketched resemble this teaching more than any other with which he is familiar. But I hope he will see also wherein they differ from it. That nature is moral I do not contend—I do not believe. So much destruction and suffering and death come upon man through flood, tornado, earthquake, pestilence and the rest, as to make this personified conception of nature untenable. What I do say is that man as

biology knows him, no less than as theology and philosophy know him, is a moral being. Notice I do not say he is necessarily a good being. What I mean is that he is a being who consciously estimates his reciprocal acts with his fellow's as good or bad and by this is moral. But since nature produces and sustains man, it must be so constituted that it can produce and sustain moral beings. I am judging nature in strict accordance with the laws of natural production, as observational knowledge finds them. An essential element in the law of organic genesis is that the germ plus its environment is sufficient to account for the completed organism. And this law is but a special case of the general law that everything found in an effect is implicit in its causes. This commonplace is brought forward to use as a stepping stone to what is not a commonplace: Examining nature broadly as we have tried to, we are able to see something of what there is in her constitution that enables her to produce moral beings. It is exactly that fundamental originative and sustentative interdependence among the parts, that basal integratedness of nature upon which we have discoursed, that endows her with this sort of creative power.

To summarize: Scrutiny of the human species in the manner that descriptive biology scrutinizes any and all species, discovers this species to have certain attributes that are very exceptional considering the animate world as a whole—desire for companionship,

sympathy with the unfortunate and the fortunate, a sense of dependence upon and obligation to others, and love of kindred and non-kindred. The possession of these attributes marks the species as not merely gregarious, but in the deepest sense social. Out of the observation and personal experience of these attributes in their best development there has grown the conception that the members of the species constitute a brotherhood. And notice that the fact that each of these attributes has its antithesis, does not in the least affect the essential point before us. Day is no less day because there is also night. The social feelings one possesses are none the less positive because of unsocial feelings one may also possess. Love is none the less love because hate exists.

The historic doctrine of human brotherhood grew out of these germinal moral feelings of man. Speculation as to the origin and sanction of these feelings has usually been sought, especially in the western world, beyond nature. But in these later centuries comes science to demonstrate the physical counterpart of the spiritual doctrine of brotherhood.

And now the final word: If ever we mortals attain to true self-wisdom, wisdom that is not alone saving but creative of Self, we shall win it by devoutly seeking in the temples of Religion, Art, and Science alternately. No man can become wise unto eternal life by worshipping in one kind of temple only.

And when such wisdom shall be reached each Self

will have become conscious that he himself *is* because other Selves *are*. Each Self will know that however much of struggle ending in triumph or defeat, however much of ambition, mean or noble, enter into the great drama of human life, it is all only a part of the stupendous totality of things, the supreme glory of which is, so far as positive knowledge can reach, that it has produced and is producing man not only at his worst, but also at his best.

THE HIGHER USEFULNESS OF SCIENCE*

I. *The Moral Accountability of Science*

IT appears that science must have to face the charge of being positively hostile to man's highest welfare. While the great war is the prime immediate incitement to the charge, not the war alone but what may be called the Great Western Conflict, one aspect of which is the war, is the real ground of the indictment. Another aspect of the conflict, the economic, is probably affecting human life more profoundly on the whole than is the military aspect. So greatly has the economic conflict, especially the labor-versus-capital part of it, gained in intensity of late years that now, when the military conflict is superposed upon the

* A paper, somewhat modified, read to a seminar of research men, the staff of the Citrus Experiment Station, Department of Agriculture, University of California, at Riverside, California, December 12, 1916.

It is worth noting that a general treatment of some scientific subject of general human interest was specially requested. This is notable as evidence that scientific specialists are not, after all, so narrow in their interests as they are often reputed to be. Indeed I am quite sure a change is coming over the face of science in this regard.

The paper has not been published before.

economic, many minds are being quickened by the appalling disasters that are befalling mankind from both directions, and searching inquiry as to what it all means—as to causes and possible remedies—is the order of the day.

These inquiries do not fail to notice that science is about the most potent instrumentality being used in both aspects of the conflict. But since science is not a mere lifeless machine or machine product, but a great department of human endeavor, it is inevitable that a measure of responsibility, social and moral, should be attached to it for the part it is playing in the conditions presented. This implication of responsibility comes to view even in the utterances of those who, from one standpoint or another, would hold that science as an operating force is something quite apart from human life. Thus: "Science . . . is neither god nor devil; science, by itself, has power neither to save nor to destroy. But we are learning at horrible cost the lesson that men armed with science can destroy in a moment human life and happiness and beauty that science can never replace." (R. K. Hack, in the *Atlantic Monthly*, Sept., 1916.)

Of course science "by itself" is neither god nor devil. It is not, because it is nothing at all by itself. It has no existence apart from the intellects and wills and hands of men. It is quite impossible to carry through the notion that science is something with which men can be armed, as they can be with swords and plows.

So much more fundamentally is science identified with the man who is said to be armed with it, than is the club or gun with which he may arm himself, that if for convenience of expression we represent it as thus detached, the good and bad which we impute to it will be quite different from the good and bad of a club or a hoe. If science is personified, the goodness or the badness attributed to it are found, sooner or later, to assume moral aspects. This seems to me a truth which scientific men have not sufficiently appreciated. Unquestionably one of the supreme virtues of science is its ability to be impersonal when occasion demands—to view facts as they actually are, regardless of anybody's interests or wishes or feelings. If the epidemic is diagnosed as bubonic plague, as such it must be accepted and preventive and remedial measures shaped accordingly. But there is a limit beyond which science can no longer operate with this impersonal detachment. Situations are sure to arise wherein it will be held to moral accountability. It is in the same boat with all the other major interests and activities of man. No human good whatever is beyond the possibility of transformation into evil. Love may be so permeated with selfishness and jealousy as to make of it a curse instead of a blessing. Some of the darkest chapters of human history are thus dark because of the passage of religion over into superstition and cruelty.

Science is still too young, ethnologically speaking, to have quite found its place in the enormous complexity

of civilized society, and one of the questions not yet cleared up is that of how far it can push certain of its socially good activities before they become socially bad activities. Science has yet to take to heart the great moral injunction about running good things into the ground. Indeed, an exceedingly important aspect of the socialization of all sorts of activity is the problem of recognizing when service passes over into disservice.

The world war now raging is apparently going to compel a very searching examination of the relation of science to the social and moral life of man. The problem will, I think, be found to have two quite distinct aspects. One of these will be a series of questions as to how far science may push its activities and applications in particular directions with good results to the community at large; or, stating the matter from the other direction, how far such activities may go before they become harmful to the community. Illustrative questions here are: How far may medicine and hygiene advantageously push regulative measures in their provinces? Where are the points beyond which their efforts would become first inconvenient, then irritating, and finally obnoxious and unbearable? How far may the principle of specialization in the study of different realms of nature be carried before the isolating tendencies reach the point where the specialist ceases to be a social being in a real sense—where the pathological bacteriologist, for example, or the electrical engineer, is no longer anything significant, even

as a biologist or an electrician? Again, and finally for illustrative purposes, how far may science go in aid of war before it will bring down upon itself first mild criticism and at last imprecation? If war really has become, as is being repeatedly said, an affair of engineering and chemistry, and if its destructiveness and horror-production should pass all bounds, is it not inevitable that engineering and chemistry should come to be looked upon as enemies of mankind? That would surely be the case should the world at large be driven to conclude that these sciences are doing more harm than good.

The other aspect of the general problem of science in its relation to man's social and moral life, is that of the influence certain basal ideas of science have on the conceptions and beliefs by which such life is guided. To illustrate, how, if at all, has the abandonment of the geocentric conception of the universe held before Copernicus and Galileo, affected the course of moral doctrine through the centuries? Would any even half-thoughtful person contend that it has had no effect in this way? Or, coming closer to our own time, how if at all has the modern theory of organic evolution affected moral ideas and moral life? Surely no one would deny, and be in earnest about it, that the effect in this case has been prodigious. To mention specifically only one item, who does not know that the catch phrase "The fittest survive, that is the way of nature," taken directly from biology, has been used as a salve

for sore consciences in innumerable deeds of injustice and cruelty, especially in the business world? And I would insist that there is no legitimate rule of law or reason by which any department of human knowledge can claim immunity from moral responsibility for the promulgation of any doctrine so potent in its influence on human conduct as has been that of natural selection and the survival of the fittest.

The general story of man's knowledge of nature and of the influence of that knowledge on his higher life, is written in type so large and language so simple as to make it seem impossible that any educated person could have missed reading and understanding it. But again has the impossible happened, to judge from utterances that come to one's ears from diverse quarters. It is surprising enough to hear a literary man of the eminence of G. K. Chesterton declare that science is "a thing on the outskirts of human life"—that "it has nothing to do with the center of human life at all." But when eminent men of science give expression to much the same view we can but ask in amazement, is it then possible that the history of science and civilization, and likewise that supreme fruitage of scientific discovery, the universal interdependency among the parts of nature, have left the intellects and imaginations of such men wholly untouched? Never shall I forget the reply an eminent biologist once told me he made to sociologists, economists, educators and so on, when they ply him with the query "what has biology to

say about our problems?" "Why, thunderation," is the way he said he answered, "biology has nothing to say about such matters!" The fact that biology should take endless pains to understand the behavior of sea anemones, earth worms, crabs, frogs, crows, mice, and the rest, but should make official declaration that with the behavior of one species alone, man, it has nothing to do except as to how his strictly physiological and some of his minor psychological activities are inflenced by certain experimentally imposed conditions, would seem about the climax of absurdity to anybody whose scientific specialization had not been in its larger significance checkmated by sophistication.

How the notion that the most distinctive part of human life lies outside the province of biology, should have gained lodgment in the minds of many biologists is not difficult to explain once one attains a critical insight into the course of biological theory during the last half century. But that we must pass now.

Almost certainly biological science will have to share with German political philosophy in the condemnatory verdict which history will pass upon some of the applications to human affairs of the survival of the fittest doctrine made in our era. This does not mean that science ought to back and fill in promulgating the truths it discovers, from humanitarian considerations. But the promulgation of fully demonstrated truth is one thing and the promulgation of half-proven hypotheses is quite another. It is only in the case of such of

these hypotheses as touch human life injuriously that moral culpability can be imputed to science. But in such cases this imputation would be perfectly natural and just, since as already pointed out science is only *one among* a considerable list of man's major interests, the harmonious interaction among which, and their working to a common end, is the very essence of good morals.

II. *How Science May Meet Its Moral Obligations*

The main task of this paper is that of trying to bring into clear light what there is within the body of science itself that may be made to work positively and mightily for the health and strength and growth of the whole of human life under civilization.

Before entering upon the task proper it will be well to have a foretaste of its character. In the first place, let us remind ourselves of the intimate way men's ideas about themselves, their estimates of their own worth and the worth of others, their personal conduct, and their treatment of other people, especially those of their own blood kin, and of strangers of alien race, have always been bound up with their beliefs and teachings about their own origin. To illustrate, think of the enormous part the doctrines of the Creation, the Fall and the Redemption of man has had in the history of Christian civilization! Keeping in mind the undoubted fact that man's theories of his own origin and

the origin of the world have always held the most vital relation to religion and ethics, ought to give the problems involved a keener, more personal interest than they otherwise would have, and so make tolerable phases of their discussion which but for such interest might seem too recondite and severe to be worth while.

The problem before us may be characterized as one which will be a search after the truth and also the error there is in such a conception as that of the "creative evolution" of Bergson. Being a little more explicit, the problem is to show that there is in nature an urge, a potency of much such operative character as that assumed by Bergson, but that it is not something outside of or behind or above or antecedent to matter, but is a coincident and essential part of the system of nature as this actually presents itself to our senses and our intellects.

Or, stating the problem from a somewhat different angle, it is to find both the truth and the error corresponding to the Bergsonian doctrine, to the end that we may benefit by the appeal an idea like that of Creative Evolution makes to great numbers of persons, but may avoid the inadequacy and unsatisfactoriness of such a theory as that of Bergson's *elan vital,* or as that of his peculiar kind of intuitionalism. No such vast and splendid body of natural knowledge as we actually have would ever be built up, I am quite sure, under the stimulus and guidance of such conceptions of nature and of scientific knowledge.

The general character of our task may be thus indicated, but this does not mean that we are plunging into a discussion of Bergson's philosophy. As a matter of fact we shall have very little to say directly about Bergson and his teachings. What the outcome of our discussion will be may be indicated by this formal statement: The doctrines of human brotherhood and of the golden rule, which in essence have marked flood tide of ethical aspiration with all the most advanced peoples of the earth, find at least as much sanction in the data of biology, if all these data be treated with logical consistency, as have the doctrines of mechanistic determinism and survival of the fittest.

Science, with biology in the lead, has advanced to the point of having produced overwhelming evidence that man in the whole scope of his being, is part of nature. This advance has given rise to a great question, not yet answered; that, namely, as to what the constitution of nature must be *because man is a part of it.* An answer of this question is, I think, one of the supreme needs of our era; and a point upon which emphasis should be laid is that a large part in the solution of the problem must be played by science if the solution is ever to be reached. I must guard against being misunderstood here. My statement that science must play a large part in solving the problem should not be taken to imply that according to my view science can do the whole business. I am decidedly not one of those who regard science as everything. What I mean is

that to science there falls a very definite, very positive share in solving the problem, but that to other departments of human interest and effort fall other shares. If you would have me specific as to other departments I should mention, by way of illustration rather than by way of full enumeration, religion and art, selecting these not so much for their unique importance as for their fundamental distinctness from science.

An effort must now be made to clarify our statement of the problem. What is the meaning of our words about determining the constitution of nature from the fact that man is a part of nature? Perhaps an illustration from a far simpler realm than that of human beings will help. "A whole is greater than any of its parts." The fact that this saying contains some truth that is self-evident seems to deter us from recognizing that it contains other truth not self-evident when the particular "whole" referred to is a natural object. The earth is greater than the American Continent or the Pacific Ocean in a deeper sense than merely that these are only two among many parts of the earth. The earth's superiority to these is not merely quantitative; it is generative as well. The American Continent and the Pacific Ocean owe their existence to the earth. Except for the interaction of various intra- and inter-planetary forces these lands and waters could not have come into being.

An exceedingly pervasive and harmful fallacy in reasoning about natural genesis is that it has made as-

sumptions and used language which imply that wholes are produced by the coming together of the previously existent completed parts, rather than by the formation of these parts coincidentally and coördinately with the formation of other parts and of the whole. The earth is not an aggregation of continents, oceans, et cetera, in the sense that these existed before the earth existed and were then brought together, as to the formation of a flock, in the meaning of the Latin ancestor of the word "aggregation." I mention here, somewhat incidentally but yet quite relevantly to our general thesis, that the cell theory in biology is pickled through with this fallacy. It would hardly be possible to get a falser view of a multicellular organism than to conceive it as an aggregation of cells, using "aggregation" in its etymological or even its common meaning. A developing embryo is a living whole *resolving itself into cells*, rather than a mass of cells coming together, or aggregating.

Returning now to our illustration, it remains to notice that the American Continent and the Pacific Ocean are two indubitable proofs of what generative capacities the earth possessed before ever these particular parts existed.

If, now, man really is a part of nature as genuinely as the Pacific Ocean is a part of the earth, then man, with his mind as well as his body, must have been implicit in nature before ever actual man existed. The existence of man's mind and the rest of his spiritual

being is proof positive that nature is capable of producing mental and moral beings, if we are right in our conclusion that man is a part of nature. In other words, mentality and spirituality and morality are among the productive capabilities of nature.

I believe that science must come to see that it has greatly curtailed its own power for good to man on the higher side of his being, by having fallen victim to essentially the same erroneous mode of reasoning about genesis in nature that seemingly most theology, certainly Christian theology, fell into centuries ago. That error consists in the supposition that judgments about the attributes and the value of things objectively presented to us, are more dependent on knowledge of the origin of those objects than they really are, and that we may acquire a finality of such knowledge which as a matter of fact we never do and perhaps never shall acquire. It is highly significant that in interpreting organic beings, modern biology should cling to its hypotheses of the production of the organic from the inorganic, and of natural selection as the cause of evolution, hardly less dogmatically than Christian cosmography clung and still clings to its hypothesis of the origin of the world and of man by divine fiat.

And equally significant is it that opinions held about the character, and estimates made of the worth of the world and of man as these actually exist, have been influenced in almost equal degree by the dogmas of origination held by Christian theology and by modern

science. Christianity's working hypothesis of the origin of man makes him a fallen angel. Very many persons suppose the fundamental conception of that splendidly terrible story *Paradise Lost* has been eliminated from modern Christianity. But it has not. The Doctrine of the Fall comes under the Yes or No form of logic. Square is absolutely not round; hence it is utter folly to try to make it so.

But on the other hand the corresponding hypothesis of modern science makes man an untransformed brute. Though he possesses much more wit than his fellows, this hypothesis says, he is yet in all essentials a brute. Do not miss the main purpose for which this matter is brought up here. It is not to pass upon the truth or untruth of either hypothesis, nor for weighing the influence each has had on human life and conduct, but for the purpose of calling attention to the indubitable fact that neither hypothesis rests primarily on inductive research upon the human species *in the totality of its manifestations*, but rather on evidence and considerations drawn from various more or less secondary and remote sources. And it may be affirmed, though the affirmation can be made only somewhat dogmatically now, that the hypotheses on both sides contain many elements which from the nature of the case are unprovable. Due attention to all the conditions makes it appear certain that exactly when and where and how man originated we not only do not know, but in all likelihood never shall know. And even more certain

does it appear that the conceptions of man engendered by both these hypotheses are hardly better than caricatures of what the best archeological, anthropological, historical and psychological investigations prove man actually to be. If ever a doctrine of man based on the facts, all of them, of *actual man* rather than on hypotheses of the origin of man, is clearly formulated, it will be something very different from the doctrines either of theology or of science, as science has been up to this time.

But now comes the important question: Would an adequate doctrine of man ignore wholly the question of his origin? Would it refuse to make any pronouncement on this question? By no means. A very definite pronouncement on man's origin would be one of the emphatic and most potent elements of such a doctrine. And this brings us back to the statements about determining what nature is because man is a part of it, and about the superiority of a natural whole over any of its parts being generative as well as quantitative.

The generative processes of nature seem to be everywhere and always such as to enable us to be far more certain that a particular generator, taken as a whole, produced its particular offspring than we can be as to exactly what part each constituent of the generator takes in the productive process, and as to exactly how the process goes on. This truth is so vital and failure to grasp it firmly has led to so much confused thinking

and futile effort in so many quarters, that illustrations of it drawn from several provinces of nature will be profitable.

For the first illustration the field of chemistry may be drawn upon, and the production of water will serve our purpose well. First of all, let us remind ourselves of the fact that the names Oxygen and Hydrogen stand as perpetual warnings against the very fallacies we are here concerned with. Oxygen is not *the* acid producer, as it was earlier believed to be, but rather, since it is now common knowledge that the attribute of acidity is often produced without oxygen, we recognize that oxygen is only one factor in the acid-production of acid compounds that contain oxygen. And similarly with hydrogen. Chemists no longer regard it as *the* cause and explanation of water even though water never exists without it. Rather it is held to be an indispensable factor in the production of water, oxygen being another equally indispensable factor. And these two factors in the generation of water are also substantive elements in the composition of water. And in the generation of water there is necessary a third factor which plays the part of a catalyzer.

Now, the mode of reasoning about water-production presents two or three points of prime importance for our argument. One of these is the fact that modern chemistry makes no attempt, as I understand, to distribute the attributes of water among the generating factors and constituents of water. For example, it

does not try to refer the refractive index of water to hydrogen, or some "determiner" in hydrogen, and the specific gravity to oxygen. On the contrary, the conception is, according to my understanding, that the refractive index and every other attribute of water is the joint product of oxygen and hydrogen acting upon each other, or possibly certain attributes of oxygen and certain attributes of hydrogen so acting. In other words, chemical generation is conceived as a process of genuine interaction among the parts of the generating mass or whole, and not as a process in which individual atoms or electrons, acting independently, produce the new bodies. The process is conceived as a *general interaction among*, rather than as the *isolated action of*, the elements or factors of the generator.

Another important thing about the rationale of the process is that this generalized or pervasive action, when sufficiently examined, leaves no room for doubt or vagueness of thought, or appeal to wholly outside forces and factors, for the reason that quantitative relations of some sort can always be discovered between the total situation presented by the generator and the total situation presented by the offspring or product; and for the additional reason that the process readily repeats itself time after time if the totality of conditions are present. In other words the real ground of certitude about chemical generation is always somewhere short of the ultimate elements and forces concerned in the operation. Chemists were just as certain

of the adequacy of oxygen and hydrogen to produce water as soon as the quantitative relation between water and its constituents was definitely established a century ago, as are present-day chemists with their much greater knowledge of the atomic and electronic structure of oxygen and hydrogen.

And finally, of supreme importance for us is the fact that the product, water, is a revelation of some of the latent capacities of oxygen and hydrogen. We are certain that these two substances, operating on each other, are able to give origin to this third substance. But how are we certain of this? Entirely because water has been observed, times without number, to come forth from the two gases; and similarly the gases have been observed to come forth from water. Could we imagine a chemist who never saw or heard of water or any of the substances chemically similar to it, we may be sure a whole lifetime of study of oxygen and hydrogen would not enable him to foresee the production of water by their union.

Take another simple case of genesis, this time from the field of physics, the production of so-called artificial magnets. We will note two ways in which such magnets are produced, namely, by breaking into two or more pieces a magnetized steel bar, each piece becoming a magnet, and by making an alloy of copper, aluminum and manganese (Heusler's alloy). The molecular theory of magnetism is apparently generally accepted by physicists as an explanation of magnetic

phenomena. The bar magnet is only the summation of its magnetized molecules. The bar is magnetic because its constituent molecules are magnetic. That seems to be, in essence, the usual mode of reasoning about the phenomenon. Let us examine it somewhat critically. We notice first of all that the molecular conception of magnetism is always spoken of either as an hypothesis, or, when the highest level of assurance is reached, as a theory. No authority whom I have consulted puts the magnetized molecules on the same plane of certitude upon which he puts the magnetized body. The base of reference in all testing of the theory is the magnet itself. That is what all experimentalists and mathematicians come back to finally for deciding whether or not a particular aspect of the hypothesis is valid.

Reflect now on just what the molecular theory of magnetism is. It supposes that magnetizable substances are composed of molecules each one of which is a potential magnet whose axes of force point in all directions, and that the conversion of such a substance into the magnetic state consists in so shifting the molecular axes that they no longer neutralize one another by pointing in all directions, but point only to the north and south poles. See what this really means. It means that the magnetizable body is made up of minute particles each one of which, though not in reality a magnet, is so constituted that it can become one. But under what conditions is this assumed ability of

the molecules to become magnets actually realized? Why, under the conditions imposed not by the molecules taken by themselves, but by their relation to the whole set of molecules constituting the particular magnetizable body. On the assumptions of the molecular hypothesis, the degree of polarity of the molecules depends upon their position in the magnet as a whole. A molecule, *a*, for example, situated so near the middle of a bar magnet that its assumed magnetic axes are diverted very little from their in-all-directions condition, becomes at once, when the bar is broken, almost entirely converted into north-south or south-north axes, depending on whether the molecule is situated on the north or south side of the break. The same molecule may become one or another kind of magnet, depending upon the whole magnet of which it is a part. In other words the explanation, on the basis of the molecular theory of magnetism, of the genesis of one magnet from another by division, is seen on analysis to depend not on the exclusively inherent powers of the molecules, but on their interrelational powers and also on their mass powers, that is, powers which they possess in virtue of belonging to the particular magnet to which they do belong. In reality the molecular theory of magnetism is an attempted explanation of the molecules of magnetizable substances based on what magnets are, rather than an explanation of the magnet based on what the molecules are; and the only real merit the theory has is that it facilitates the

quantitative treatment of magnets.*

This conception of magnetism as a fundamentally interrelational phenomenon between molecules and masses of molecules, is exhibited with special clearness by the magnetic phenomena of various alloys. One of these that seems to have attracted unusual attention among physicists is known as Heusler's alloy. This, as already indicated, is composed of copper, aluminum and manganese. It is said to be the most strongly ferromagnetic of all known alloys. The significance of this for the point we are here making is very obvious when it is remembered that each of the metals, copper, aluminum and manganese, taken by itself, is always regarded as non-magnetic. Note how this magnetic alloy illustrates the general proposition that some attributes of the parts of a natural whole, are determined by the whole itself. If it be really true, as authorities seem to agree, that copper, aluminum, and manganese are, taken separately, non-magnetic, we can not even say that they are proved by the magnetic alloy to be *potentially* magnetic in a full sense. All that is proved is that each is potentially able to *coöperate with* the others in producing the magnetism in the alloy. Heusler's discovery that this alloy is magnetic was the discovery of a hitherto unknown attribute of copper,

* It has recently been suggested that the ultimate magnetic particle is not the molecule but the atom or something within it. But there is nothing in the revised hypothesis that would affect the reasoning here presented.

aluminum and manganese, though exactly what that attribute is was not discovered, for the investigators have not determined what part each plays in making the alloy magnetic. One investigator, we learn from Chwolson (*Traité de physique*, t. 4, p. 883), has tried to refer the magnetism of the alloy to the manganese, but this is found unsatisfactory and Heusler himself regards it as due to a chemical combination of a sort peculiar to the metals.

So here again, as in the production of water, we have conclusive proof of the generative power of a complex *in its totality*, but without knowing what part each constituent plays. We are absolutely sure of the competency of the whole to account for the phenomenon presented, though this falls short of certainty about the part played by the ultimate elements.

But it is when we pass to the organic realm that the truth of our statement of how we interpret generative processes in nature stands out most boldly. Much has been made in the modern era of interpreting man in the light of his origin. This is good so far; but more notice ought to be taken of the truth that in reality we also interpret the origin of man in the light of what he is. The general truth illustrated by this statement will be made clear by familiar facts drawn from the two fields of ontogenesis and phylogenesis, i. e., individual development, and race development. That in the actual laboratory work of studying ontogenies the various stages are interpreted in the light of what is

known of succeeding stages, is familiar to every biologist. But that the student would be quite helpless with the developing organisms were it not for his knowledge of what they are to become, seems not to be sufficiently noticed. That such antecedent knowledge is essential, is manifest from the many cases in zoology where larvæ which undergo radical metamorphosis were discovered before the adults of the same species were known, or at any rate before the larvæ were known to be the young of the particular species. What has usually happened in these cases is that either no attempt was originally made to tell what the adult would be, and so to determine the taxonomic position of the larva; or an entirely wrong guess as to its true nature and affinities was made. The point is unequivocal once one reflects on it. There are absolutely no observable attributes in the germinal elements of any organism or even in the advanced larvæ of many (when these are regarded by themselves) on which predictions can be based of what they will develop into, just as there is nothing observable about oxygen and hydrogen taken separately that forecasts water, or about copper and aluminum and manganese that forecasts magnetism in Heusler's alloy.

Shift now the point of view to phylogenesis and see how the principle works there. The origin of new kinds of plants and animals by mutation, about which so much has been learned in late years, brings out the point. What botanist or zoölogist would pretend that

by studying a given species of plant or animal he could tell when it is going to give rise to a mutation and just what the mutant would be? It is highly probable that after a large amount of critical knowledge of mutations occurring in particular groups has been accumulated, something in the way of rules or laws of mutation will be made out, and that it will be possible to say in a general way that such and such mutations may be expected. But no one should fail to see what a vastly different matter this would be from foretelling by examining a given plant or animal *as such*, that it will produce a predescribed mutant at a specified time.

The cases of natural genesis, inorganic and organic, which we have considered, show two things of great importance for our general conception of nature: first, that there is a limit beyond which scientific prediction of generative processes can not go, either in inorganic or in organic nature; but second, that this limit is so placed that it leaves no need for the assumption of extra- or supernatural forces to account for what is produced.

These limitations to prediction are due, as we have seen, mainly to the fact that observational knowledge is excluded from direct hold upon what is latent in nature. But at the same time that the very nature of our knowledge limits our ability to predict future natural products, it gives us certainty that the generators are the sufficient explanation of the products.

It will be worth while to exhibit the implications of this argument in their historic and general setting. This can be done to good advantage by seeing how it accords with the usual mechanistic view concerning the predictability of natural phenomena. Huxley's famous statement of that view will serve our purpose well. "If the fundamental proposition of evolution is true," Huxley says, "that the entire world, living and not living, is the result of mutual interaction, according to definite laws, of the forces possessed by the molecules of which the primitive nebulosity of the universe was composed, it is no less certain that the existing world lay, potentially, in the cosmic vapor, and that a sufficient intellect could, from a knowledge of the properties of the molecules of that vapor, have predicted, say, the state of the fauna of Great Britain in 1869, with as much certainty as one can say what will happen to the vapor of the breath in a cold winter's day."

If we have correctly described the course of interpretation of natural genesis in the above instances, and if these instances are typical for all such interpretation, then there is much to criticize in such a mechanistic view of the constitution and evolution of the world. First of all, there is much ground for questioning the assumption of a condition of "primitive nebulosity" for the entire universe; a condition, that is, in which only molecular forces, as we now understand them were operative. For example, what is the evidence that gravitation, which presupposes considerable

masses, existed only as a latent attribute of molecules? But let that pass. It is not the point in the statement specially open to attack on the principles we have been examining. Nor is the vulnerable point in the contention that the existing world once "lay potentially in the cosmic vapor." Since the existing world is an undoubted reality, it undoubtedly did once lie potentially in the cosmic vapor—if such a vapor ever actually existed. The point upon which our assault must be directed is the assertion "a sufficient intellect could, from a knowledge of the properties of the molecules of that vapor, have predicted . . . the fauna of Great Britain in 1869." The trouble with the assertion can be brought out by asking, what would be a "sufficient intellect" to make such a prediction? Answering this in the light of what we have learned about the nature of experiential knowledge, we see that no amount of augmentation of power, or content of such intellect as ours, would be sufficient, but that a wholly different kind of intellect would be necessary. This is so because, constituted as we are, we have no *sense with which to observe potentiality and no thought method* with which to conceive it. Nor have we an inkling of what kind of sense or what kind of thought could do that, even supposing it might be done. What sort of sense would it be, do you think, that would perceive water in oxygen and hydrogen? Do not fail to make the distinction between seeing potential water in oxygen and hydrogen, and finding certain properties in the

gases that would enable one to foresee that the gases might under certain conditions combine and transform into water. There is a far profounder difference than mechanistic reasoning takes cognizance of between the attributes of oxygen by which we know it here and now, and those in virtue of which it produces water upon reacting with hydrogen.

Bergson has passed much this same criticism on the claim by science of the power of prediction, but his argument makes use of the element of time in a way that, taken in connection with the criticism advanced above, may make more obvious the validity of the criticism. Time, Bergson says, "is deprived of its efficacy" by such conception of foreseeing as that proposed by Huxley. This mode of statement involves Bergson's peculiar view of the nature of time. But we can make the time element help our criticism without commitment to any theory as to what time is. Put it this way: Perceptual knowledge is wholly dependent upon the *actual* attributes of the perceived object. It is the very quintessence of such knowledge to be thus dependent. But all chemical action is known to require a certain amount of time, however small. That is, some time is required for the actual attributes of a chemical product to evolve from their latent condition in reacting elements. Hence for one to claim that he is able to predict the attributes of the product from the elemental substances is equivalent to claiming that he can annihilate the time required in chemical action. Stated

comparatively and in the rough, the intellect that would be capable of predicting the British fauna of 1869 from the cosmic vapor out of which the world is supposed to have been produced, would be one endowed with genuine clairvoyant powers; one capable of foreseeing independently of the mechanism and experiences requisite to all ordinary foresight. In a strict sense prediction of what will occur in nature is wholly conditioned upon knowledge of what has occurred, and consequently an intellect so endowed that it could predict the present world before ever any such world had existed, would be one so endowed that it could interpret natural phenomena without any experiential knowledge of such phenomena—a result exactly antithetic to what Huxley's whole practical life and teaching stood for.

It is now high time to see how the various arguments, scattered, somewhat bunglingly and obscurely, along the road over which we have come, stand us in hand toward the fulfillment of our main task, that of showing that science has moral obligations and is able of her own strength to meet them. If the two propositions be accepted that we have absolutely no way of knowing what nature is capable of producing excepting from what she actually has produced; and that she is seen to be self-sufficient for the production of all we actually find in her providing we recognize a sufficiently wide range and large number of factors as operative in the generative processes, then, obviously,

in order to understand rightly her productive powers and to be able to forecast with the highest attainable correctness what in future she may bring forth, it is of the utmost importance to have the broadest, most reliable knowledge possible of her actual products. Due appreciation of this puts one, *eo ipso,* in the frame of mind for what Whewell has called the natural history method of philosophizing, and on which I dwell somewhat critically in the last essay in this volume.

From now on our occupation will be with man, and this reference to the natural history method of philosophizing is made to carry us across from the logico-scientific argument in which we have been engaged, to the logico-humanistic argument that is to follow. Recent philosophic discussion of human history has, we are informed (E. G. Teggart, *Prolegomena to History,* p. 66), made much of the fact that history is concerned primarily with names and deeds which are individual and largely unique and isolate, while science deals primarily with the general principles and laws of nature. This is one of the chief reasons, it is said by some, why a scientific treatment of history is impossible. The much discussed question of whether history in the usual meaning of the word is or can become a science does not directly concern the present argument. What does interest us very closely is the contention widely made that the main if not the sole business of science is with the repetitions and recurrences in nature; in other words with general rules and laws, and that in the

individual, the unique, the exceptional, science has only a passing and uncompelling interest. This theory of the nature and aim of science is in large measure responsible for the view that science touches only the edges of human life. Man's social and all higher life is too personal, too single, too exceptional, it is affirmed, to admit reduction to law, and consequently is incapable of scientific treatment.

Now I insist that the natural history mode of dealing with nature can not possibly be ignored by consistent science, and that this method is a natural corrective and filling out of the partial view of science above indicated. From this standpoint the present essay is a complement to the one referred to a few sentences back, in which the cardinal aim is to show the essentiality and indispensability of description, definition, and classification for all departments of biology. The argument there is designed to show that occupation with individuals—individual organisms and individual parts of organisms in endless array—is exactly one of the most distinctive features of biology, and that such occupation is of the very essence of the natural history method. In the present essay I have tried to show that when dealing with the genesis of living things, or for that matter of all natural things, regard for single objects and events, even objects and events which have much of uniqueness about them, is in reality unescapable. Science can do absolutely nothing with magnetism apart from individual magnets.

The concluding section will present a few special cases of the fundamental interest of science in organic individuals, even in unique individuals, and will at the same time reveal the grip man's moral nature has on his intellectual, his esthetic and his religious natures. If nature's ability to produce men is really to be judged by the men she has produced, then it must follow that the exceptions, or, if there be such, the wholly unique men must be just as important so far as this criterion is concerned, as are the most commonplace men. If it be literally true that the world has produced only one Napoleon, it nevertheless holds that Napoleon is just as indubitable a proof of nature's man-producing ability as are the thousands upon thousands of the rank and file of soldiers who made up his armies. And the same is true, of course, for any of the other members of the human species who by reason of their deeds stand as much alone among their kind as does Everest among mountain peaks, the Pacific among oceans, or giant redwoods among trees.

One is familiar enough with the objections to viewing supreme geniuses in this way. They are not natural products at all, in a strict sense, it is said. This denial receives a show of defense by a variety of more or less inept or loose or untrue assertions, an examination of which would be profitless even had one the time for it. There are, however, two types of view given in support of the denial that geniuses are really natural which demand attention. One holds them to be

a sort of accident or artifact, produced by their particular age and environment acting on a mere substratum of physical genesis and heredity. The other looks upon them as special acts of an over-ruling Providence, as strictly human beings perhaps but yet sent at special times because of special needs calling for special talents.

From the facts we have been seeing and the reasoning we have been going through, it will be easy to perceive our preparedness to rebut both these forms of denial that geniuses are natural products. If one will base his inquiries into and his speculating about the production of Napoleon on the sum total of positive knowledge of the man himself and the whole set of environic conditions which acted upon him, rather than upon one's general knowledge and doctrinal predilections about heredity, variation, environmental influence, and so forth, he will, I think, come into a full-fledged sense of certitude on two points, or rather on one point viewed from two directions; namely, that Napoleon was in the strictest sense a natural being, i. e., a natural product; and that the fact of his personal and public life is proof of nature's generative ability for the military type of the human species.

Contention for the naturalness of the completed lives and labors of geniuses may on first impression seem rather far-fetched, but may be helped toward normality by a remark which has considerable expository importance. That remark concerns the question of

whether human actions and the results thereof shall be regarded as natural; the question, in other words, of what is natural and what is artificial. Large and important as this question is from some points of view, for the present discussion it can be disposed of quite summarily if we have felt the full import of the natural history mode of interpreting nature, one of the mandatory tenets of which is "neglect nothing" when bent upon the complete interpretation of any organism. Put the query about the artificiality of man's acts and fabrications alongside the same query about the acts and fabrications of any other animal. Is the burrow of a ground squirrel—assuming the squirrel dug it—artificial or natural? Is the "comb" of the honey bee artificial or natural? Is a bird's nest or a beaver's dam artificial or natural? Is an Indian's wigwam artificial or natural? Is the White House at the end of Pennsylvania Avenue artificial or natural? Is not this a perfectly homogeneous, consistent series of questions? Then some one answer must be applicable to them all. That answer is this: The artificial holds the relation to the natural of species to genus, in the sense of formal logic. The artificial fabrication is one kind of natural fabrication; the kind, namely, that is produced by nature through the volitional operation of some animal rather than through the immediate operation of natural forces. This argument might be differentiated and veered and checked endlessly without impairing its substance. The State, the military cam-

paign, the Drama, the Statue, the Church, even though all admittedly artificial, are yet natural, and their artificiality must acknowledge the overlordship of their naturalness.

To objectify as much as possible the apparently infinite and infinitely varied productivity of nature, even within the limits of the human species, send your thoughts hastily to just a few representatives of the world's supremely great men. In the field of war and conquest take Napoleon and Alexander; in that of government think of Lincoln and Hideyoshi; in literature, of Goethe and Shakespeare; in science and discovery, of Newton and Columbus; in delineative art, of Rembrandt and Michelangelo. And on the dark side think of Cesare Borgia and Nero. I protest against the strong tendency of recent biology to become so absorbed with "analyzing the germ plasm" as to become obsessed with a doctrine that makes it necessary either to "explain" these mighty figures in terms of hereditary units of some sort, or pronounce them mere accidents, or "by-products of natural selection" or "epiphenomena," so not falling within the pale of scientific interest and treatment!

With the greatest deliberation I express the opinion that the history of science from its dawn until now is nowhere disfigured by a more monstrous folly than that of the germ-plasm theory in its extreme form, for it is largely responsible for the theory held by much of recent biology that the higher manifestations

of men's lives are by-products of natural selection (the view of orthodox Weismannism) or are incidents of the interaction between Heredity and Environment regarded as two modern Fates, and so outside the realm of science.

The list of great men given above contained no examples of geniuses in the realm of morals and religion. What about these? It is just here that almost all formal philosophy has held the generative powers of nature to fail. The incompetency of such powers to account for the origin of man is specially seen, so philosophy asserts, when we come to consider what history presents in these realms. "Almost all," I said, of the great philosophies have believed nature inadequate at this point. A partial exception to this is the system of moral philosophy inseparably linked with the name Confucius. Of the several ways in which the teachings of this great man, so much neglected by the western world, ought to become a vital force in that world, I can touch only a few, one of which is his inculcations on mental morality. "When you know a thing," Confucius says in one of the Analects, "to hold that you know it, and when you do not know a thing, to acknowledge that you do not, that is knowledge." "In these words," writes M. M. Dawson in his recent volume, *The Ethics of Confucius*, "Confucius set forth more lucidly than any other thinker, ancient or modern, the essential of all morality, mental honesty, integrity of mind—the only attitude which does not

close the door to truth." I agree with Dawson that Confucius appears to have seen the vital importance of mental morality more clearly than it has been understood by any philosophy which has gained practical importance in the western world, not even excepting the Platonic and the Kantian.

It is desirable to be explicit as to wherein the philosophies which have had greatest ethical potency in western civilization have gone seriously wrong. Neither Christian theology nor modern science has frankly acknowledged the limitations to what they know about the origin of man, of living nature generally, and of the world. They have assumed more understanding than they have on the subject, and on that assumption they have based judgments and estimates of men and society and nations. Most disastrously important of all, the hypotheses concerning man's origin which they have erected into dogmas, tend to the belittlement, even to the degradation of man. The "poor worm of earth" theory of man that has figured so largely in Christian teaching; and the "nothing but" chemical substances, and animality, so persistently preached by recent biology, are distinctly subversive of all that is best in human nature.

Let us return to Confucius for a moment. The emphasis he put on mental morality was part and parcel of his general reverence for learning and truth, and learning for him meant investigation of things—*common things*. "Looking up he contemplates the brilliant

phenomena of the heavens, and looking down, examines the definite arrangement of the earth; thus he knows the causes of darkness and of light," the basal aim of it all being to see the world whole. "I seek unity, all pervading," he said; and investigations thus prosecuted and truth thus attained lead to virtue. And be it specially remembered that the great learning and insight and virtue which all are agreed Confucius possessed, were his through the possession and exercise of physical and intellectual and spiritual powers common to all men. "I am not one who was born in the possession of knowledge," he said, "I am one who is fond of antiquity and earnest in seeking it." In short, and this is a matter of supreme significance, Confucius and his followers elaborated a truly magnificent moral system without any claim to miraculous or supernatural aid. We may say, I think, that a higher, more potent, strictly rational moral philosophy is hardly possible.

But the verdict of history and the testimony of experience stand as conclusive proof that the Confucian moral system, splendid as it is, is yet inadequate for the modern world. It lacks something. What? It lacks that peculiar driving force which nothing but religious faith seems able to supply. That is why, I suppose, Confucianism has supplemented itself in China and Japan with Buddhism.

So much for one of Asia's great religio-ethical gifts to mankind. Turn now to another which is, both

ethically and religiously, almost the complete antithesis of Confucianism. I mean Mohammedanism. Mohammed may be characterized as a man possessed of very unusual endowments, among which the religious instinct was the most powerful, and the moral instinct about the least powerful; and who lived in an age and environment which, because of these basal endowments, developed him into a religious monomaniac whose sensibilities to the rights and dignities of his fellow-beings generally became reduced to almost nil. It is impossible to appreciate Mohammed and his work rightly without recognizing the true grandeur of the prophet's proclamation of the singleness and unity of God, and as a corollary, of the idolatrousness and perversity of holding any other being or thing as on a par with God; and at the same time his detestation of unbelievers, which of course meant the vast majority of mankind. "If God should punish men according to what they deserve, he would not leave on the back of the earth so much as a beast," we read in the Koran. (*The Creator*, last sentence.)

What about the synthesis that would include all that is true of Confucianism and Mohammedism? Before giving my answer to this query, I would call attention to the fact that the teachings of Confucius and Mohammed contain elements which adumbrate the possibility of such a synthesis, that element being the struggle of both men toward unity. "I seek unity, all pervasive," said the great Chinese. "I teach the unity

of God," said the great Saracen.

And now for the categorical answer which I propose to the query just made. The ethico-religious teachings of Jesus come nearer effecting the desired synthesis than any yet given to the world, but they do not complete the synthesis, the remaining defectiveness being on the intellectual side. This defect modern science is in position to make good so far as is possible in the present state of the world's advancement. The particular resources of science which are available for use toward this synthesis are the generalizations which are being reached as to the nature of the individual and the relation among individuals and in the domain of what I have called bio-integration. What the generalizations are in these two domains I have attempted to summarize in Biology's Contribution to a Theory of Morals, the third essay in this volume. The import of the generalizations of supreme importance for the present discussion may, however, be stated as follows: The interdependencies among the individuals of the human species are found to be such, when traced through on the principles of bio-integration, as to constitute a solid scientific foundation for the doctrine familiarly known as the brotherhood of man, out of which has grown that aphoristic guide to conduct, the Golden Rule. The whole range of considerations in the above-mentioned essay, and those set forth in this one, justify the conclusion that the full meaning and grandeur of the ethical doctrines given in outline by

Jesus, can be grasped only when they are perceived to be in strictness part and parcel of what we call the natural order, or the system of nature, the "frame and substance of the universe."

The loftiness and inspiration of such a conception of man's nature and chance of progress is enhanced by noticing in bird's-eye view the course over which world-civilization has run, and where it now stands.

All the great religious and some of the greatest ethical philosophies of the world have come, as has apparently man himself, out of Asia. No world-moving religious idea has sprung from Europe or any of the other continents. Europe, on the other hand, has greatly modified and elaborated one of Asia's religious systems, Christianity, and has originated two or three ethical systems of first importance. But the supreme contribution of Europe to civilization has been Science—Science as a vast body of positive knowledge, as a distinct way of thinking, and as a characteristic outlook upon the world and human life. So far the gifts of Europe to civilization are glorious beyond comparison, for Asia and the other continents have contributed only subordinately to science in the stricter sense.

But the story of Europe's achievements has a very dark side. With all the expanding and refining and uplifting forces it has brought to bear on man, it has not been able to stay or even greatly to control his fighting and marauding and despoiling instincts. The

military and political and economic developments that have taken place under the leadership of European motives and ideas, have been in the nature of an intensification and elaboration of these instincts, apparently inherited from his animal ancestors. The history of Europe presents a record of cruelty and man-inflicted suffering and internecine bloodshed without parallel in the histories of other peoples and other lands.

It appears justifiable to forecast that could such a synthetic moral philosophy as that here indicated be made, one consequence would be the bringing of man's acquisitive and hoarding and combative instincts into proper correlation and subordination with his other more definitively human instincts.

Finally, may we not—do we not—discern signs in the type of civilization which is struggling forward in the Americas, particularly in North America, that these recently possessed continents may now add their world-encompassing, world-moving contribution to civilization, that contribution to be the very synthesizing of religion, morals, and science, which our discussion has revealed might, on rational grounds, be anticipated? The signs which seem to me most premonitory of such a consummation are the aggregate of ideas and ideals and tendencies in both Americas which we commonly though not very definitively name democracy, and the development in the United States of what I venture to call scientific philosophy.

To be only a trifle more specific as to what I mean

by scientific philosophy, reference is made to the general thought movement known as pragmatism, leadership in which is universally accorded to William James and John Dewey.

But having said this much I can not pass the subject without remarking that according to my view this new philosophic movement can never reach full clarity and operative force in human affairs until supplemented from the side of science itself, that supplementation to come from what I have called, taking a cue from William Whewell, the natural history method of philosophizing. Something of what this method implies is shown in the fourth essay of this volume.

BIOLOGY'S CONTRIBUTION TO A THEORY OF MORALS REQUISITE FOR MODERN MEN *

I TRUST no apology is needed for bringing such a subject as that which I have chosen before a company of professional naturalists. As a matter of fact, if there is need for apology at all in this connection it is for the backwardness of naturalists in inquiring what bearing their labors have on the deepest and dearest of human concerns.

To men of science like myself, whose faith is mighty that there is no human interest so deep and so dear that science may not make it richer, the growing distrust of science in our day, which only the blind can fail to see, is disquieting. Whether, as some are disposed to charge, science is inimical to all man's higher welfare except his intellect, I do not inquire. The comparatively restricted question of the relation of biology to morals is what is to occupy us for a period.

* A paper read before the San Diego Meeting of the Western Society of Naturalists, August 11, 1916, and published as Bulletin 2 of the Scripps Institution for Biological Research of the University of California. The title under which the essay was orginally published was: "Biology's Contribution to a System of Morals that would be Adequate for Modern Civilization."

But manifestly even this can be touched at only a few points.

At the outset I would be clear, beyond the possibility of being misunderstood, that while I am profoundly convinced that biology has a far deeper meaning for morals than either biologists or ethicists usually recognize, nothing is more antipodal to my thought than the notion that ethics may be "reduced to" physics and chemistry or even to physiology. Indeed the "nothing but" philosophy of life is, according to my view, one of the direst factors in the present diseased state of civilization.

Special care has been taken to make the wording of my subject suggest what I believe biology may do for ethics. It is not my idea that biology can *displace* ethics, but that it can *contribute something* to ethics. More specifically, I believe biology must assist ethics in the task of making itself more scientific—more exact of definition, more explicit and positive in its mandates, more self-compelling in its authority. Wherein biology is now in better position than ever before to serve ethics I must indicate though I can do so only in a very brief, oracular way, for it seems best to devote myself chiefly to some of the needs of such service.

Probably all who think earnestly on any of the major questions presented by man in modern society, would agree that about the most basal of these questions is that of how a better status as between man the individual and man the member of society—

between individual and social man—may be attained. Buried deep in the technical details of biological knowledge there repose truths which if brought into the light of common day and set in right relation with certain truths of human nature, would, I believe, contribute to establishing the inviolability and potency of *the individual* on a securer foundation than either science or philosophy has hitherto been able to lay down. Likewise from the same obscurity may be extracted truths which would give a more solid and commodious base than has yet been constructed for an understanding of the *interdependencies among individuals* in civilized society.

The great point about individuality is that researches in the comparative structure, function and behavior of living beings, combined with comparative biochemistry, is leading to the perception that closely related species and even individuals differ from one another in certain attributes so profoundly that these differences extend down to the very chemical constitution of these beings. Considering this fact along with the further fact that every organism maintains its identity despite the perpetual flow through it of matter and energy called metabolism, there is seen to be no escape from the conclusion that the organism is creative in the deepest sense. The synthetic limb of the metabolic cycle results in some substances and forces that have no exact duplicates anywhere in the world. But if there are certain differentials in the chemical

syntheses produced by two organisms which in their general features are so alike that there are no differentials at all in the chemical substances which enter into these syntheses, that is, in their nutrition, then there appears nothing for it as concerns causal explanation but to hold that the causes of the differences in the products lie chiefly in the organisms and only secondarily in the chemical substances used. Although so far chemists have made out little or nothing about just how the human organism uses chemical substances in accomplishing its intellectual, volitional, and moral ends, yet we confidently infer that these like all other organic activities have their peculiar chemistry; and there is ample ground for supposing that future research will discover much about the nature of the chemical processes involved. The importance to the higher life of man of this conception of the organism's relation to its food and drink and the air it breathes can hardly be overestimated. If living beings really have mastery to this extent over their environment, then is man at his highest level a mighty being indeed in the world of universal causation, for he is one of the most unique and most potent of all these causes. Individuality, personality, under this view is in some sense restored to the supreme place conceived for it by the philosophies of self-realization. "In some sense," I say, is there such restoration; for the difference between this psycho-physiological and the former metaphysical conception of personal power is that science

is in position to mark out certain definite limitations to such power. Thus while the group of activities we call consciousness is seen to have power to cause changes in material substances, this power is limited to the few simple substances that are used as nourishment by the organism. Furthermore there are all the limitations to which the volitional and rational life is subject by general physical laws. But he who recognizes himself to be by nature not only "captain of his soul" but of his body, even though that captaincy be subject to the conditions indicated, undoubtedly has a freedom and joyousness, and a passport to physical and spiritual health and strength that is impossible for him whose faith is of the uncompromising determinist sort.

It seems clear that such virtue as Christian Science and other forms of "Mind Cure" have touching bodily conditions—and that they have virtue in this way no candid observer can possibly deny—is due to their having come, emotionally rather than rationally, upon certain aspects of the truth that the human organism has a measure of real control over its metabolic processes as well as over others of its functional activities. It will be a long forward step on the road of personal happiness and efficiency when through common education and normal living, men shall have possessed themselves of all the virtues but dispensed with all the vagaries of Christian Science.

The biological truths referred to as basic material for a better understanding of the interdependence

among men, are truths of what we may call bio-integration. The phenomena under this head have been forcing themselves upon the attention of biologists with special insistence during the last two or three decades. Appearing first in the realm of embryology under the ill-defined caption "the organism as a whole," investigation made manifest the inadequacy of the cell theory as applied to the developing individual. The essence of this discovery was that while the cells of an embryo are independent units in a sense, in an equally important sense they are subordinate to a higher unit, the organism itself. Otherwise stated, the discovery is that *integration is as primal and essential a phenomenon in the development of the individual as is differentiation.*

Passing from embryology to physiology through such discoveries as those on the integrative action of the nervous system and of the internal secretions, we are now reaching the conception that within the individual *coördination of labor among its cells and organs is as primal and essential a phenomenon as is division of labor.*

Simultaneously with these advances in embryology and physiology, psychology has moved swiftly forward along the road of integration. The psychology of the human individual has made great strides in demonstrating the interdependence of the physical and spiritual aspects of man. This it has done chiefly through revising its basal conceptions so as to make them include

the affective and emotional sides of man's nature as well as his intellect, which almost alone received serious consideration by the old introspective psychology.

Finally psychology has now pushed its frontier far enough into the domain of man's social relations to begin to give definiteness to the hitherto illy defined popular assertion that man is a social being. The extreme outpost of progress in this direction is the recognition that the individual mind in the sense of the Pure Reason psychology of two or three decades ago is an abstraction. The demonstration that man's existence as a self-conscious being is conditioned on the existence of other objects, some conscious and some non-conscious, is the highest point yet reached in the discovery of the integratedness of nature—in attaching a clear meaning to the phrase the *system of nature;* for it reveals not only physical man, man with the attributes of size, form, weight and physical and chemical activity, but also spiritual man, man with the attributes through which are created the fine arts, literature, the physical and social sciences, religion and so on, as an integral part of the system.

That this contention that the series of bio-integrations thus briefly sketched, extending without interruption from the very chemico-physical and cytological basis of organisms up through the whole living world to the most complex phenomena presented by civilized man in society, constitutes the biological groundwork of a science of morals, I earnestly commend to all

thoughtful persons, especially to biologists and ethicists.

Contenting myself now with the mere dogmatic assertion of the great importance to ethics of the biological discoveries thus called attention to, I devote myself to pointing out conditions in the civilization of our day that ought to set every student of biology, no matter in what department, to inquiring earnestly what his professional obligations are as touching the moral welfare of the race. I venture to express the view that the utter indifference of many well-stationed biologists toward these matters is prima facie evidence not merely of social recreancy on the part of these persons, but of grave defect in the fundamentals of their scientific point of view.

I wonder if we men of science are viewing with as much complaisance, even levity, as we pretend to, the bizarre growths in the realm of man's religious instincts that flourish so luxuriantly all about us? I suspect a considerable number of us are beginning to question whether the whole thing is as much of a joke as we had supposed; whether indeed these growths may not be something more than a few scudding clouds in the prevailing clear sky of our modern rationality. But even if attention has been arrested to this extent, I find little indication that men of science regard the matter as a real phenomenon of modern civilization, and as such deserving attentive study. Indeed it seems as though excessive specialization in scientific discipline

is schooling students away from the ability to take broad expanses of diverse natural facts into a single view and then to push analysis under perpetual guidance of the dominating whole. Instead of treating jocularly, as we have been wont to do, these religious vagaries, is there not ample ground in the nature of the case for taking them as proof that man's religion-producing instincts are bound to assert themselves in one way or another, and that if they are not recognized and guided to some extent by reason, by science, they are prone to develop into such misshapen forms, even such monstrosities, as we are seeing? Surely it is not the spirit of science at its best to treat all phenomena as a joke that do not come easily within its pre-established doctrinal boundaries. If there is one thing more than any other that ought to characterize science as contrasted with dogma, it should be its perfect readiness to revise its fundamental conceptions at the behest of indubitable evidence.

That the great range of manifestations which has Billy Sundayism at one end of one main axis and the mystical tendencies in liberal Christianity at the other; and on another axis has Christian Science at one end and the transplantation of Oriental occultism into the west at the other end, is in reality one coherent system of phenomena, seems not to have attracted the attention of many observers. And how many biologists, or even sociologists, are taking notice of the great vogue in this country of writings on astrology and are con-

necting this in any way with the "return to religion" which, according to the testimony of many witnesses, is so conspicuous in Europe under the ordeal she is passing through? What is the meaning of the New Thought movement? Why does it flourish so? Has it any relation to these various other things to which reference has been made? No student who will regard all these phenomena in the light of the revelations of modern research into cultural anthropology, and of what psychologists are teaching us about the psychology of religion, can fail, I believe, to recognize that none of man's attributes are more deep-rooted and wide-spreading than the group which makes him what we call religious. Nor can he fail to be convinced, if he examines these manifestations attentively, that they all belong to this realm.

No one, especially no one in a company of naturalists, needs to be reminded of the traditional enmity between theology and science. With the monumental work of Andrew D. White as part of the working library of all English-speaking men of science, it may be taken for granted that so far as concerns the historic aspect of this matter, information is ample and judgments are clearly drawn. As touching present conditions and future possibilities and probabilities, the case is quite otherwise. Many of us have lulled ourselves into somnolence on this matter by believing that the victory of science is at last complete. But the time seems opportune for words of warning. How

many persons were there in the whole United States three years ago who did not fully believe that such a conflict as is raging to-day in Europe was both physically and morally impossible or at most only remotely probable? Shall we, men of science, especially drilled in the difficult art of impersonal observation and forecasting, fail to learn from the many lessons now before us how mighty and ineradicable are the great primal instincts of the human species? Is an era of priestly and ecclesiastical domination more inconceivable to-day than, a few months ago, was such an outbreak of the fighting impulse as we are now witnessing? Any one disposed to scoff at this query would do well to turn an attentive eye upon the indications of a renewal of life in quarters where religious dogma is still enforced by churchly authority.

Concerned as I am here with the problem of morals, I would have preferred not to touch this chronic open sore on the body of civilization, this conflict between science and theology. Nor should I do so but for the fact now coming into clearer outline than ever before, that it is impossible to treat the problem of morals with anything approaching adequacy without passing into the domain of religion. This truth is now coming into clearness just because the problems of both morals and religion are getting themselves more scientifically treated than ever before.

In the earlier stages of the effort toward a science of morals, in the purely analytic stage, when morals and

religion were first sharply differentiated from each other; when the significance of the historic truth that religion may be highly immoral while a high moral plane may be reached with little mingling of religion, the disposition on the part of some students was to believe in the complete dissociation of the two. Now, however, that the scientific study of both realms is becoming synthetic as well as analytic, the deeper insight is being reached that while there is a positive distinctness between morals and religion, and a kind of separateness, yet the two are correlated and interlocked in the most complex fashion. Absolute disjunction of the two provinces is no longer to be thought of. In this the traditional teaching of Christianity is right.

This brings us to where the essence of what I am trying to set forth can be put into a nutshell. All progress toward a system of morals capable of standing the strain of modern civilization has been toward a scientific morality; that is toward a natural morality. But the truth has been repeatedly pointed out by recent students that in the past the most influential moral systems have depended upon belief in the *supernatural* for their highest enlightenment as to moral duty, and for executive power in the enforcement of moral mandates. In a word, the chief moral doctrines of the past have been rooted in faith in a supernatural order rather than in faith in the natural order. But progress in civilization has now reached a stage in which a system of morals resting finally on belief in

the supernatural is breaking down. Further progress in our type of civilization is dependent upon the adoption of a well-rounded system of natural morality. Splendid progress in this direction has already been made, and so far as the domain of moral doctrine itself is concerned there would seem to be no great obstacle in the way of continuing on the same road. But the moment advance in natural morals comes squarely face to face with the problem of faith in the supernatural groundwork of morals, it touches the exceedingly sensitive spot of man's religious faith in the supernatural; and right here trouble begins.

A point which I wish to insist upon—though to present it in detail is quite beyond the possibilities of an essay like this—is that a conception of nature worked out fully and freely in the synthetic as well as in the analytic way; that is, in conformity with the universal integratedness of nature, as well as in conformity with nature's differentiatedness, would satisfy those basal instincts of man upon which religion rests no less certainly and fully than it would furnish an adequate basis for morality. The greatest defect in natural science is, I am quite sure, its failure clearly to recognize that its conception of nature must be comprehensive enough to include man in the fulness of his being. During the last half-century the achievements of science in making out what man's place in nature is, are of incalculable importance. The next great task for science is to show what *nature is because man is a part*

of it. One consequence of the accomplishment of this task will be a system of morals immeasurably richer than that under which civilization is now floundering. The second essay of this volume is a small contribution to the task.

THE PLACE OF DESCRIPTION, DEFINITION AND CLASSIFICATION IN PHILOSOPHICAL BIOLOGY*

I. *Scientific and Logical Aspect*

Empirical theory of knowledge tends to regard detailed, complete description as identical with explanation. (Professor R. Adamson.)

. . . it would hardly be too much to define logic as the theory of classification. (W. S. Jevons.)

Science can extend only so far as the power of accurate classification extends. If we can not detect resemblances and assign their exact character and amount, we can not have that generalized knowledge which constitutes science. (W. S. Jevons.)

. . . the mathematical and mathematico-physical sciences have, in a great degree, determined men's views of the general nature and form of scientific truth; while natural history has not yet had time or opportunity to exert its due influence upon the current habits of philosophizing. (Wm. Whewell.)

* A modified and extended paper read before a naturalists' meeting of the Pacific Division of the American Association for the Advancement of Science, at Berkeley, California, August 3, 1915.

I WISH to point out in the briefest way possible the vital importance to biology of the truth of these statements.

We are familiar with the view that the transition from the pre-Darwinian to the Darwinian era of biology was accompanied by a complete revolution of conception as to the significance and value of our systems of classification of living beings. The current notion is that the old taxonomy was superficial in that it was merely descriptive, but that, with the oncoming of the doctrine of evolution, it became profound because it then became a record of evolution. While formerly we are wont to say, the schemes of classification were only logical, or verbal, those of the present era are truly scientific, because natural; and they are natural because based on genetic kinship. And in the minds of many biologists the still further notion has gained lodgment that systematic zoölogy and botany should be looked upon as marking the juvenile period in the life of biology; and as having been outgrown and left behind when evolution came, something as a boy's falsetto voice and beardless face are left behind when adolescence is reached. It is this view, I suppose, which makes many a present-day biologist feel that if by chance he is caught having anything to do with description and classification, he must explain that it is only a little by-play with him, that he is not really interested in it, it being too small a matter to merit the full occupancy of his manly powers.

I want to show three things: first, exactly what has happened to taxonomy as biology has progressed; second, something of the monstrousness of the fallacy into which biologists have fallen in conceiving taxonomy as an outgrown stage in the development of biology; and third, something of the wretched consequences that have resulted from the fall.

A quotation from Huxley's "Owen's Position in the History of Anatomical Science" may serve as a starting point of the discussion:

"The classifications of the scientific taxonomist are of two kinds. Those of the one sort are merely handy reference catalogues. . . . The others, known as *natural* classifications, are arrangements of objects according to the sum total of their likenesses, in respect of certain characters. . . . And natural classification is of perennial importance, because the construction of it is the same thing as the accurate generalization of the facts of form, or the establishment of the empirical laws of the correlation of structure."

That which makes taxonomic biology as practised by many systematists genuinely superficial, and has so depreciated its value in the minds of many biologists, is failure to distinguish sharply and see the profound significance of the difference between the two sorts of classification referred to by Huxley. The sort of classification which he calls "merely handy reference cata-

logues," I call *synoptic classification*, and remind the reader that such classification rests upon *synoptic description*. The other sort of classification, said by Huxley to be of "perennial importance, because the construction of it is the same thing as the accurate generalization of the facts of form," I call *analytic classification*, and ask the reader to note that it rests on *analytic description*, just as synoptic classification rests on synoptic description. And here I must state that analytic description and classification will include considerably more, as I use them, than was included by Huxley in his second sort of classification.

In order to bring into clearer view the close kinship between the biological and the logical aspects of our subject, we shall so choose our language as to fix attention quite as much on the *meaning of the names* used, as on the natural objects to which the names are applied.

If any one is disposed to shy at the proposal thus to connect biology with logic, he may be reminded of a dictum of one of the most famous and also the most objective of biologists, Cuvier. "In order to name well, you must know well," said the father of comparative anatomy. The import of this straightforward statement is that natural science deals with natural objects and that the names of these objects are the instruments by which the work is done. As a speculator, Cuvier did not escape the common weakness of the class, that of permitting Ideas so to intrude them-

selves between object and name as to prevent assurance that the two should really fit each other; but as naturalist he stood firmly for the practise of making both knowing and naming apply very directly to the object. So far he was on the road to the sound position later definitely taken by J. S. Mill as a logician, that common sense is right in calling the word which stands for an object the name of the object, and not merely the name of our idea of the object.

Biology and logic, as understood in this discussion, have very much in common in that biology can do nothing with the natural objects which are its subject matter except through the instrumentality of a great lot of names; while logic can do nothing really significant with names of ideas concerning living beings unless those ideas have their exact counterparts in the objects themselves.

To be explicit, we shall deal with the description, definition and classification of *man;* but instead of doing this in the usual terminology of the systematist, we shall talk about the meaning of the word "man."

Imagine a normal child born on an oceanic island, the only animal inhabitants of which are its mother and itself; and imagine further that the mother, an educated woman, has taught her child all sorts of things, except about other human beings or other animals. Not the smallest fragment of information has she imparted to the child about its own kind, other than its mother. What would be the character of the

child's knowledge of humankind? Does any one question that it would be considerable, definite and real? Would not the child know its mother's form and countenance and voice, and many other things about her, just as well as though it knew innumerable other people? Unquestionably. It would have a descriptive, but no definite knowledge of man, except in so far as the knowledge of itself would be differentiated from its knowledge of its mother.

Authorities on logic make a good deal of the point that "the concrete individual object can be described, but not defined." And they say, furthermore, that description is synonymous with "accidental definition," this latter being again defined as assigning the "accidents" of an individual. But since the "accidents" of an object have been, according to much historical logic, set over against its "essence," "accidents" have usually been treated by logic as a sort of Cinderella, the homely, despised sister, in the family of so-called Predicables.

I find justification for going thus much into logical doctrine in the fact that recent biology has shown a strong tendency to follow formal logic in exalting essence and despising accidents.

The practical point to be brought out is this: no matter how insignificant, or obscure, or transitory, may be a certain attribute of an object, in so far as that attribute is positively and repeatedly observed, it furnishes just as trustworthy a piece of knowledge about

that object, as any attribute whatever can furnish.

Suppose the mother of our hypothetical island child had a mole on her chin; or that the sunshine brought out freckles on her nose which disappeared again during the winter. These marks would be accidents, according to logic; and biologically regarded would be quite insignificant. But they would be as indubitable elements in the child's knowledge of its mother as any other elements that can be mentioned.

Let me ask any reader who is "keen" enough on the different kinds of automobiles to be able to distinguish most of the "makes" as they are passed on the road, what marks he relies on for identifying each type of car? Is it not true that in most cases you depend upon one or a few very trivial things? Color comes in; but, on the whole, one finds himself giving less attention for identification purposes to this conspicuous attribute than to others far less conspicuous. Just now the shape and color, not the name, of the manufacturer's plate placed on the radiator of so many machines, is a good identification mark for machines coming toward one. For the rear view of a machine with the top up, the number and shape of the window panes in the back curtain are useful marks.

The purely logical points deserving emphasis in this familiar but typical case are: first, the trustworthiness of the identification marks in spite of their triviality. The number and shape of the windows in the back curtain are just as positive and real as traits, that is,

logically regarded, they are just as important attributes of a particular class of machines as the number and shape of the cylinders; and second, the fact that using the marks in the way we do is purely descriptive, so far as concerns the recognition of an individual machine, but is definitive in so far as that machine is differentiated from any other kind of machine. Had there never been more than one automobile made, so that then there could be no question of distinguishing it from others of its kind, the windows would still be no less positive and real, though, manifestly, they would not then furnish distinguishing traits within the general class automobiles. But here there comes to view a difference of the utmost importance between the way attributes are definitive of man-made objects like automobiles, and natural living objects like men. In the first class of objects we are perfectly sure that many, usually most, of the attributes which the old logic would call accidents had no genuinely dependent relation to most of the other attributes of the object; while in living beings, especially of the higher classes, we are now certain that the great majority, if not all, the attributes, even those which formal logic would call accidents, are in vital relation with many, usually very many, other attributes. Thus recurring to the shapes of back curtain windows in automobiles and freckles on the nose of our hypothetical island mother, we know that the former have no fundamental relation to the more essential attributes of the machines, as, for ex-

ample, the style of engine or carburetor or magneto; while on the other hand we know with equal certainty that freckles are vitally related to, indeed are wholly dependent upon, various other attributes, notably the attribute known as complexion, which again is vitally related to the blood system, and so on.

There are few, if any, points at which biology is more at sea than in this very matter of the factual and logical, *i. e.*, the objective and subjective relation of the attributes or traits of organisms to one another and to the whole.

We now return to the problem of defining the word man. By the time any normal child is four or five years old he is in possession of the raw materials of a fairly comprehensive and entirely reliable description, a less extensive, but still unequivocal, definition, and the first of the essentials of a classification of man. He positively knows some of the attributes which distinguish a man from a house or a rock; some of those which distinguish him from a tree; probably some of those which distinguish him from a fly; probably, too, some of those which distinguish him from a chicken; and almost certainly some of those which distinguish him from a dog, a cat, a cow, and a horse. In a word, he has the raw material for the synoptic description and classification of man; that is, for the synoptic meaning of the word man.

Attention should here be called to the fact that the synoptic classification of man as elementary biological

instruction presents it is apt to be slighted at its two ends. Too frequently, the beginning is made with:

Kingdom,	*Animal,* and runs on:
Province,	Metazoa.
Phylum,	Vertebrata.
Class,	Mammalia.
Order,	Primates.
Genus,	Homo . . . and end with
Species,	*Sapiens.*

The point of criticism is that the super kingdom, the Empire (if our terminology must retain its ancient monarchic coloring), is not constantly enough included at the broad end; and at the narrow end the subspecies or variety is more frequently slighted than it ought to be; and from the very apex the individual is almost entirely ignored.

"*Empire,* Living Being, or Organism, or Bios" ought to be always included as the logician's genus generalissimum; and, at the other end, "*Individual,* Eleanor, Ezra," etc., ought to be always included as the logicians species specialissima or infima species.

The synoptic description, definition and classification of man would then be: any natural body which is multicellular, has a vertebral column, suckles its young, habitually walks erect on its hind limbs and uses its fore limbs for prehension, and talks rationally. And this is, too, both a biological and a logical meaning of

the word man.

It is desirable to raise the question at this point as to the difference between the biological and the logical meaning of the term man. The kernel of the difference seems to me statable thus: The briefest possible biological meaning of the word spreads it out, as one might say, evenly over the whole living world, while the briefest possible logical meaning does not do this. The insular mother whom we invoked in imagination may be supposed to teach her child formal logic, and, in so doing, to make use of herself and her child to illustrate the logician's use of the terms genus and species. She might say to the child:

"You and I are natural bodies like the rocks and the clouds; but since we talk with each other, a thing which neither rocks nor clouds can do, we are particular kinds of natural bodies. When bodies stand in such relation as this to one another, we, as logicians, speak of them as being in the relation of genus and species."

So far as I can see, this example, if supplemented by others of like import that might be drawn from inanimate nature, could be made to satisfy completely the needs of formal logic as touching its doctrines of naming, defining, dividing, classifying. In a word, formal logic is not obliged to take cognizance of the fact that living nature contains any organisms other than man himself. Logic is something that can be used

upon living beings generally with great effect—something that can occupy itself very interestingly and profitably with such things, but it is not obliged to be so used.

Logic goes to nature to get illustrations of how thought works rather than actually to learn nature. Reverting to Jevons's sttement that logic may be defined as the theory of classification, we may remark that, so far as external nature is concerned, while logic may be defined as the theory of classification, it can not be defined as the practise of classification. It is important to call attention to this distinction between logic and biology since even biologists frequently fail to recognize it and are beguiled into trying to impose the laws of thought upon nature by asserting that such and such a supposition about nature is a "logical necessity." Although logic is so important to the natural scientist as an instrument, quite as important is it never to forget that it is only an instrument. Logic is one of the many children of nature; it is not its parent or ruler.

A practical point to be noticed here is that right regard for logic in the business of the taxonomist clearly reveals both the unwarrantableness and misfortune of the view, so widely held, that synoptic descriptions and classifications are artificial or puerile, and devoid of scientific value. If such a definition of man as that just given does not express his nature—is not a natural definition—in what terms, pray, can he be

naturally defined? The definition is natural, but meager. This and not its artificiality is its fault; and from this fault arises the need for the second kind of classification spoken of at the outset.

To this other sort of classification and the second meaning of the word man, we now turn. Logic lays great stress on the difference between extension and intension in the meaning of names. When the word man is merely thought of as applying to the individuals of the human species, its meaning in extension is before us. When, on the other hand, thought goes to the attributes of man, to what makes him a man, rather than to individual men, it is occupied with the meaning in intension of the word.

Now, as to our point about the second, the analytic classification of man—the analytic meaning of the word man. Let us begin with the reminder that meaning in intension is concerned not with the mere naming of objects, but with the attributes of the objects named.

Let the reader recall that taxonomic research in both zoology and botany has for years, so far as it has been based on morphology exclusively, taken as one of its guiding principles *neglect nothing*. This means, stated in the terms of logic, that this aspect of taxonomy has incorporated into its purpose and method, the study of terms in their intension. This is really, I believe, what was in Huxley's mind, at least in the background of it, when he asserted that the second kind of classification is the "same thing as the accurate gener-

alization of the facts of form."

A prime object of this paper is to contend that biology has now reached a stage in its progress where we can no longer restrict our dictum "neglect nothing" to morphological attributes, as the above quotation seems to take for granted, but must extend it to all attributes of organisms whatever—morphological, physiological, ecological, chemical and all the rest. And it should be pointed out that the movement of biology in this direction was more or less distinctly seen by at least one biologist nearly a century ago, namely, G. R. Treviranus. "The doctrine of organization," he said, "is founded upon comparative anatomy, or the systematic distribution of living bodies, and on organic chemistry."

I believe a comprehensive review of the whole range of biological results won during the last five-and-twenty years, let us say, will convince any one that each of the main provinces of research—comparative physiology, ecology, experimental behavior, genetics and biochemistry, no less than histology, cytology, embryology and regeneration, would furnish differentia for a classification of the organisms used in the researches; or at least that they contain differentia corresponding to the systems of classification previously established on the basis of pure morphology.

What does this signify for the attitude of biologists toward their problems, and for methods and enterprises of research?

It signifies many things, one of which particularly concerns us now, and may be put into the following general proposition: No biological phenomenon is adequately interpreted or dealt with experimentally, until it has been considered with reference to the place that the organisms to which it pertains hold in the system of classification. To illustrate, no generalization about the chromosomal structure and behavior in the spermatogenesis of species *x* of genus *a* can be accepted as fully valid until compared with the chromosomal structure and behavior of species *m*, *n*, *o*, *p*, etc., of the same genus. And a like restriction must be placed on generalization about the reaction of species *x* to light, or to any other stimulus, or to its distribution in nature, and so on.

To undertake the recital of special researches in support of this proposition would be to undertake the review of most of the recent investigations in the provinces of biology mentioned. And notice this: The results of these researches look in the direction indicated despite the fact that in most cases the studies had little or no systematic aim. The great amount of evidence of this purport is mostly incidental to other motives of investigation.

I would not be understood as advancing the hypothesis that every species of plants and animals differs from every other species to some extent in every attribute. What I affirm is that the inductive evidence has now gone so far toward proving every sharply differ-

entiated species to contain some differentia in all the main provinces of their structure and function, that to assume the absence of such differentia in any given case, is unwarranted.

Although in the interests of practical biology it is desirable that a searching examination of the whole range of biological knowledge should be made from the taxonomist's standpoint, for a short theoretical discussion like that in which we are now engaged all that is incumbent upon us is to look, and that only cursorily, into a single province of biology, namely, biochemistry. This is all that is necessary, I say, because the analysis of all phenomena of life into chemistry and physics being the ultimate goal of biology according to the now dominant biological philosophy, if it turns out that the chemical analysis is exhaustive only when done on the basis of taxonomy, then it would seem to follow necessarily that all phenomena of structure and function intervening between the grosser morphological features with which taxonomy has for the most part busied itself, and the ultimate physico-chemical features, must also be brought to a taxonomic basis before they are exhaustive.

It would be difficult to find a better example of weightiness of inductive evidence as dependent upon cumulation in particular lines, and convergence of different lines, than that presented by biochemistry bearing on the hypothesis here under consideration. Concerning the evidence of the chemical differentiation of

species drawn from investigations on the blood of higher animals, recall the results of Reichert and Brown on the crystallization of hemoglobin. Here is one of their statements:

"Each form, *a*-oxyhemoglobin, *b*-oxyhemoglobin, etc., appears always in its own proper form and axial ratio when the blood of different individuals of the same species is examined. . . . But upon comparing the corresponding substances in different species of a genus, it is generally found that they differ one from the other to a greater or less degree; the differences being such that when complete crystallographic data are at hand the species can be distinguished by these differences in their hemoglobins."

Let us assume there is ground for questioning the full trustworthiness of this conclusion. Notice the strong presumption of its general reliability produced by its accordance with evidence from a wholly different kind of research on the serum of blood, namely, that on the precipitin reaction; and from still another kind, namely, that on the hemolytic action of one blood upon another. Nor should we fail to recognize the convergence of evidence for chemical specificity of organisms drawn from comparative investigation on milk, on the enzymes of digestion, and from such direct analyses of organic structure as those of the sperm of many species and genera of fishes. I mention only one other line

of evidence of like purport clearly to be counted as chemical, though not usually so cited, namely, that of the odors and flavors of plants and animals. This is an exceedingly rich field of inquiry, even though difficult of cultivation by ordinary laboratory methods. The methods to be chiefly relied upon here are those of the senses of smell and taste, and it is interesting to reflect that there is available for utilization not merely these senses in man, but in animals as well. In the olfactory sense of the ant and the scent hunting dog, for example, we have a method of chemical discrimination—of qualitative chemical analysis if you please—which seems to surpass in delicacy anything laboratory manipulation can hope to attain.

Natural history and biochemistry are being inevitably drawn together by the very nature of their subject matter. Descriptive zoölogy and botany are becoming chemical in part, and biochemistry is becoming zoölogical and botanical in part. Organisms are indeed being "reduced to chemistry" in the familiar phrase; but the statement tells only half the story, unless it specifies the *particular* chemistry to which they are reduced. Each kind of organism has a chemistry to some extent unique. In one of its aspects biochemistry is becoming a subdivision, or branch, of systematic zoölogy and botany, just as anatomy has been for a long time. "Almost any group of tissues," said Minot, "would offer a favorable opportunity for the discussion of genetic classification." Apparently the same may be

said of biochemical substances.

Many biologists working in several provinces of the organic realm, particularly in those which, like cytology and biochemistry are concerned with the minute and difficultly observed structure and functions of organisms, appear to be laboring under the delusion that they are doing something totally different from description. They seem to think their work apart from and exalted above description if they can apply the terms analysis, or especially causal analysis, to it. As though the treatment of causal factors which are intrinsic in an organism were not part of the description of that organism, and as though causal factors extrinsic to the organism; that is, belonging to the organism's environment, were essentially a part of biology at all! I believe full and unbiased consideration will convince any one that the word analysis, occurring so frequently in recent biological writings, always means *analytic description and classification,* as these terms are elucidated above, if it has any objective meaning at all. It is undoubtedly true that as touching organisms themselves a vast amount of analysis has been practised upon them that is not descriptive; but this is because it is purely speculative—because it is subjective and not objective. Most of the analysis of the characters of adult organisms into "determinants," "determiners," "factors," etc., of the germ, is of this sort. And as touching the environments of organisms it is a remarkable thing, once one comes to notice it duly, that the

results of innumerable researches have been published in biological journals during the last two or three decades, that were not in a strict sense biological. The studies were undertaken not so much to learn the nature of organisms as to test the properties of certain physical and chemical agents in respect to their influence on organisms. Incidentally, one might almost say, they have brought out many suggestive facts about how organisms may behave when placed under unusual and unnatural conditions. But they have not taught us very much about the normal behavior of normal organisms under normal conditions. Indeed, a considerable number of biologists have been so bewildered by what they have seen and by their mode of speculating, that they have seriously questioned whether there is such a thing as a normal organism in a normal environment!

The sooner it is borne in upon the minds of all students of living beings, no matter with what aspects of such beings they may be occupied, that they are engaged in the great task of describing and classifying the living world; and, so far as "pure biology" is concerned, are doing nothing else, the sooner will objective biology get itself set off from subjective biology and the sooner will philosophical biology become purged of the many morbific growths which now impair its health and mar its beauty. Never more than in this present day when experimental research has gained so wide and lasting, and, on the whole, beneficent a hold in

biology, has there been need of fidelity to description and classification. Never more than now, I say, because the practical work of experimentation on organisms does not promote observance of the classifier's watchword "neglect nothing." Indeed, when the experimental method is raised, as some enthusiasts try to raise it, to the high place of an end in itself, the tendency is rather to neglect everything except the one or very few things which the experimenter must of necessity make the object of each special piece of work.

Although the practical biologist knows that his strivings after explanation are utterly futile unless always accompanied by description, the spell of subjectivistic metaphysics is still so strong over science that not many biologists have yet grasped the fact that all true explanation is reached through description. Investigators rarely seem to notice that the explanations they propose are usually in reality hypotheses, and that the proof, or the greater or less probability of truth, of these explanations (hypotheses) is wholly dependent upon the accuracy and fullness of description to which the organisms are subjected in the aspects of them to which the explanations pertain. Take the classic case of Goethe's explanation of the flower as a transformed branch with its leaves. Is it not true that just in so far as this explanation is accepted it is done on the basis of the accepted description of flowers and branches and leaves? If a true explanation of cancer is ever reached does any one fail to recognize, when he

thinks about the matter, that it must come in the form of well-verified description and classification of the whole complex of organic phenomena implicated in the disease?

A true though incomplete distinction between description in the ordinary sense and explanation in the ordinary sense is that the process of describing is very little guided by hypothesis, while explaining is very largely so guided.

II. *Philosophical and Ethical Aspect*

Early in the paper, I promised to say something about the baneful effects that have flowed from the neglect by modern biology of the principles of description and classification. *Sine systeme chaos*, is the motto standing at the head of an elaborate recently published work on the arrangement of the animal kingdom. This motto should be adopted, in substance at least, for any and every comprehensive biological treatise, no matter in what field; and I insist that failure to adopt it has thrown the speculative biology of our time into a literal state of chaos.

The revolt against the dry and formal nomenclatorialism into which biology had wandered in the period immediately preceding Darwin, has gone so far as practically to deny that many of the really best established, most important names in biology have any essential meaning at all. Witness, for example, the effort now

taking shape with a few biologists, notably with J. S. Haldane, "to raise the term organism to the level of a category," as Henderson has characterized Haldane's undertaking. As a matter of fact, the effort is to restore, not originally to elevate the term, for a study of the history of biological theory clearly discloses that the term organism was long ago accepted as a category in the very best writings. For example, whenever the cell is interpreted as an "elementary *organism*," as it usually has been since Brücke first conceived it thus, *organism* is acknowledged to be a "category"—a real entity—of biology.

From the extreme devotion to description and classification which characterized the older biology, the new has gone, in several of its most important aspects, to the opposite extreme of scarcely any accurate description and classification at all. Very few biologists appear to have considered how this attitude toward systematization has affected philosophical biology, and especially the biology of man, and so the general theories of human life, and influence upon human conduct.

We approach here a matter of vast scope, one altogether too vast to be more than touched in an essay like this. But there is one segment of it which, though lying close to the field of biology proper and of great importance, appears to have attracted the attention of professional biologists but little.

I refer to that melange (the thing will not allow itself to be called a system) of utterances and more or less

definite teachings about the human species that has got into men's minds during the last thirty or forty years, and has found its fullest expression in the writings of Friedrich Nietzsche.

Surely biologists have not taken as much note as they should of the insistence by philosophical anarchists and other disciples of Nietzsche that their prophet is the particular and supreme "philosopher of evolution."

Into the tumultuous whirlpool of discussion of the Nietzschean doctrines I have no wish to enter, at least in this place; but a few things about it ought to receive consideration by biologists, especially by American biologists. Should the matter be thus attended to, I believe it will be seen that there is a great measure of truth in the claim for Nietzsche as the philosopher of evolution, evolution being conceived as it usually has been in the modern period; and the particular point I want to make is that he did his philosophizing, primarily about man and very secondarily about the rest of the living world, in all but total disregard of, seemingly in almost total ignorance of, the natural history aspect of biology. His appeals to physiology, or something he called physiology; and to some of the results and conceptions of physiological psychology (although I do not recall his having used exactly this phrase) were constant and often very telling. But his neglect of, yes, more than that, his positive antipathy for the systematic, the coördinational, the interdependent as-

pects of living nature are striking indeed, once one comes to study his works with the point in mind. I have searched, vainly, both in his own writings and in those of several professed followers of his, for evidence that the conceptions organism and organic, with the meaning these terms have to every genuine natural history biologist, enter in any definite and positive fashion into his philosophy. And here is the point that ought to arrest the attention of scientific men, indeed of all thoughtful persons: So far as concerns this vital matter the Nietzschean school is in strict accord with the "habits of philosophying," now dominant in biology.

Listen to this, one of Nietzsche's "Apophthegms and Darts" occurring in the "Twilight of the Idols":

"I mistrust all systematizers and avoid them. The will to system is a lack of rectitude."

What a familiar sound this has to those who, from being at home in the discussions of recent speculative biology, have had dinned in their ears the doctrine that systematic zoölogy and botany are old-fashioned, childish and insignificant. Of course any one even moderately acquainted with Nietzsche's writings knows that what he was aiming at primarily in inveighing against systems was the systems of traditional philosophy. And undoubtedly, as Mügge remarks: "many have been drawn to him for this very reason." Presumably most persons, be they scientists or philosophers, be they

admirers or detesters of Nietzsche, would easily and willingly recognize that he knew little and cared less about the systems of natural history. They would go further and say that that fact had no essential relation to his antipathies against systems of philosophy. And this brings us back to the main point—the point to which, according to my view, neither men of science nor men of philosophy have given sufficient attention, namely, that the system, the orderliness which every educated person now knows to be so greatly characteristic of living nature, must enter fundamentally into any philosophy of man and the animate world generally in order that that philosophy may be even approximately true and in any way adequate.

The following quotation from "Beyond Good and Evil" will open the way to a perception of the kindred between Nietzscheism and modern theoretical biology. He says:

"Let me be pardoned as an old philologist who can not desist from the mischief of putting his finger on bad modes of interpretation, but 'Nature's conformity to law,' of which you physicists talk so proudly as though—why it exists only owing to your interpretation and bad 'philology.' It is no matter of fact, no 'text,' but rather just a naïvely humanitarian adjustment and perversion of meaning, with which you make abundant concessions to the democratic instincts of the modern soul."

The items in this which specially concern us are the references to nature and democracy. Nietzsche appears to have felt as genuinely and deeply as any modern whatever the importance of "return to nature"—a cry which, though hackneyed, he was willing to adopt. For this feeling he is entitled, as an esthetic philosopher, to great credit. The keenness of perception and vigor of expression with which he protests against the repudiation of external nature, the vilification of the human body, and the distrust of the senses, as these abominations have manifested themselves in the great systems of historical philosophy from the later Greek period, on through the heyday of Christian theology, down into the modern era of German subjectivism, deserve the careful and sympathetic regard of every man of science. The best of his utterances under this head which I have found are contained in "Beyond Good and Evil," and "The Twilight of the Idols." The chapter on "Prejudices of Philosophers" in the first mentioned, and the sections, "The Problem of Socrates," "Reason in Philosophy," and "Morality as Antinaturalness" deserve special mention.

The disastrous mistake made by Nietzsche and into which his disciples have followed him, was in believing that he *actually did* "return to nature." As a matter of fact he never came any nearer nature than did Jean Jacques Rousseau, who raised such a hullabaloo a century and a half ago over the same subject, and for whom Nietzsche professed such an ardent hatred. It is

easy for a student of real nature to understand why Nietzsche hated Rousseau more spleenishly, if such a thing were possible, than he hated people generally. Probably it was because he vaguely realized that he was doing just what Rousseau tried to do, *i. e.*, *make* of nature what he would like to have it; and then saw that what Rousseau wanted nature to be was almost the antithesis of what he himself wanted it to be. While Rousseau wanted nature to be peaceful, gentle, benevolent and all that, and so easily found enough in it to make himself believe it to be essentially of this sort, Nietzsche as easily found enough in it to convince him that in its fundamentals nature is of the sort he liked, that is, selfish and powerful and hard and cruel.

Biologists ought to examine right carefully Nietzsche's famous doctrine of "Will to Power." His effort to make this a universal and all-sufficing principle of living nature had its strict counterpart, if not, indeed, its inspiration and model, in struggle-survivalism of the Weismannian type. And the doctrine has degenerated into a sort of fiendish crotchet with many of Nietzsche's disciples, much as strugglism has with many biologists. And the reasoning, if reasoning it can justly be called, is much the same by the two sets of persons. "Wherever I found living matter," said Nietzsche, "I found will to power, and even in the servant I found the yearning to be master." (Thus spake Zarathustra.) As an illustration take an alligator, a great hunk of "living matter," sunning itself

on a sand bank for hours at a time without so much as flopping its tail. What a striking case of willing to power! And what determination of a servant to be a master! Or if Nietzsche by chance ever looked through a microscope at the slow come-and-go of protoplasm confined within the cell membrane in a hair of a spider-lily, what a convincing proof of "will to power" and "desire for mastery" he had before him!

And one finds illustrations and arguments quite as convincing almost every time he consults any orthodox Selectionist. For instance, such a biologist will watch with you a hornbill, a bird the size of a hen with a bill as large as the horn of a two-year-old bull, as the creature strives to get its bill out of its way so it can see its food, and then displays its ingenuity in getting the food far enough back in its immobile, bony mouth to enable it to swallow the morsel, and will explain to you without a smile how this bird and its ancestors have been able to survive in the struggle for existence because of the masterful bill! Or, coming down to pure and overwhelming logic, such a biologist will affirm (still without a smile) that you are bound to accept his explanation of the hornbill's bill unless you have some better explanation to offer! And he will go yet further (still in dead earnest) and tell you *he*, and not you, must be the judge of which explanation is better. A very rudimentary sense of humor is another and by no means an unimportant trait-in-common between Nietzscheans and many speculative biologists.

But that in particular which ought to make these biologists join with the disciples of Nietzsche in proclaiming their prophet the supreme philosopher of evolution is intimated in the following quotation:

"Nature's conformity to law is no matter of fact . . . but rather just a naïvely humanitarian adjustment and perversion of meaning with which you make abundant concessions to the democratic instincts of the modern soul."

The tap-root of the life philosophy of both groups is the dogma that the gross, easily seen living things about us everywhere and all the time are "mere outward expressions" of an Essence, deep, invisible, intangible, a comprehension of the working of which and the control of which is the goal of all life science.

To be sure, the fact that temperamentally Nietzsche was highly artistic and very little scientific made him interpret and evaluate human life in terms very different from those used by the biologists when they treat of man. But the close kindred between "Nietzsche's cloud-like visions of Eternal Recurrence and Superman" and the nebulous hereditary substance, germ plasm, and "The Fit" of most biological eugenists should not be overlooked by anybody interested in problems of human welfare. Nietzsche's followers have not been slow to see the meaning of the man-breeding proposals of our day. Mügge says:

"In Galton's Eugenics, founded upon the idea of evolution and the assumption that the human will is in some small measure capable of guiding the course of evolution, we see a scientific realization of Nietzsche's dreams."

And let no one, especially in this democratic country of ours, neglect to mark well the character of those dreams: Autocracy carried through to its logical end. The best shall rule and "by means of force." The best shall be masters; the community their slaves, literally and not figuratively. The only law shall be the law of the strong, the fit.

Those eugenists whose biological philosophy rests on germ-plasmic fatalism, appear not to have recognized —probably because the goal is so far away—that they face toward an aristocracy most hateful to one who knows what democracy really means. Here again Nietzsche was more far-sighted than his biological counterparts, for he clearly saw and loudly proclaimed that supermen must be a very few very select masters with the great common "herd" their slaves.

And so our discussion turns back to its beginning. The laws of interdependence, of reciprocal connection and action which seem to pervade all living nature and bind it into a great, infinitely complex unity are only a seeming, only an outward manifestation of the ultimate Reality, so many biologists accord with Nietzscheans in declaring. The "web of life" of which the ordinary

man recognizes himself to be a part and which vulgar natural history strives to describe and define accurately and to classify naturally, is of little profit or interest because unreal or at best semi-real, say these biologists.

We may hope a generation of students of nature will arise after a while, a majority of whom will genuinely believe and act in accordance with their faith, that common sense has a real part in the interpretation of nature. And when such biologists come and succeed in making themselves heard and felt there may be ushered in an era of rule of the best who will be indeed best because they will rule according to the law of the whole and not by the law of some Being above or beneath or somewhere else outside of nature, whether called superman or the fit, or by some other name.

It is high time that natural history should "exert its due influence upon the current habits of philosophizing."

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